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Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Volume 1 JANUARY, 1930 Number 4

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THE MONTH'S HIGH LIGHTS IN OILDOM

By J. L. DWYER

DURING the month of January, 1930, there were three outstanding events in the petroleum industry: The adoption by the Standard Oil Co. of New Jersey of a base price for gasoline, to which is added the freight rate from the refinery to the point of destination; the decision to operate the Van field in East Texas under the unitization plan; and the sharply increasing production of the Oklahoma City pool.

The new method of handling refinery sales as adopted by the Standard Oil Co. (New Jersey) constitutes a radical departure from the methods formerly employed. In past years the refining company, through its sales agency, announced a flat price for each state, and in New Jersey the tank wagon price was the same at Freehold, Newark or Lake Hopatcong, regardless of the distance of any of these points from the refinery where the gasoline was manufactured. Under the new system the Standard Oil Co. announces a base price at the refinery, and to this base price is added whatever freight rate prevails between the company's refinery and the destination of the product. At this time the new system is only in effect in the Atlantic seaboard states and, while there has been much speculation as to whether it will spread to other localities, no announcements concerning this possibility have been made.

The Van field in East Texas has been the scene of much interest during the month. It is now being operated under a unitization plan, with the Pure Oil Co. in charge of operations in the pool. Should Van prove to be a major pool, as many are inclined to believe it will, the process of handling it under the unit basis will prove interesting. The companies owning acreage within what is thought to be the outline of the structure will each have a representative on the board of management of the pool, and the board of management of the pool will function similarly to the board of directors of a corporation. This plan has been highly successful as long as dry holes were being drilled, and just how it will work out in the handling of a producing pool will be extremely interesting.

The output of the Oklahoma City pool continues to mount very sharply—so sharply, in fact, that it threatens to exercise an unfavorable influence upon the crude price structure unless some more effective curb be used. The production of this pool is now far in excess of the pipe line capacity, and the crude-purchasing companies are rather reluctant to amplify the current purchases in the area, as there has been a concerted effort to reduce crude stocks.

In viewing the future of the crude oil situation, the weather conditions will play an important part, and an early spring will do much to add stability to a crude market which is very much in need of that quality.

From a standpoint of production, the national situation shows little change. The daily average output of the Oklahoma fields naturally shows some increase on account of the sensational rise of the Oklahoma City pool, while the remainder of the country is somewhat stationary. California is holding its own, the umpire system now making evident the benefits of holding down production. West Texas hovers close to the 350,000-barrels-per-day mark.

From a national viewpoint, the recently introduced practice of making a base price for refinery products and adding the freight rates on the Atlantic Coast district may have some effect upon the transporting of California refined products through the Panama Canal.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending December 28, 1929

(Figures in Barrels of 42 Gallons)

DISTRICT	Per Cent Potential Capacity Reporting	Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	3,363,500	79.3	6,140,000	7,836,000
Appalachian	91.8	549,900	66.8	1,267,000	795,000
Ind., Ill., Ky.	98.6	1,975,300	79.5	4,975,000	3,523,000
Okla., Kan., Mo.	88.6	2,018,300	70.4	3,538,000	3,401,000
Texas	90.7	3,678,700	74.7	6,692,000	14,135,000
Louisiana - Arkansas	97.1	1,274,000	62.3	1,978,000	4,848,000
Rocky Mountain	93.6	351,000	36.0	2,193,000	1,008,000
California	99.3	4,378,500	73.4	15,177,000	109,606,000
Total Wk. Dec. 28	95.5	17,789,200	72.3	41,960,000	145,152,000
Total Wk. Dec. 21	95.3	18,074,000	73.6	40,451,000	144,683,000
The Texas and Louisiana Gulf Coastal figures shown below are included in the totals of their respective districts:					
Texas Gulf Coast	100.0	2,948,100	80.0	5,646,000	11,153,000
Louisiana Gulf Cst.	100.0	887,200	71.4	1,698,000	3,958,000

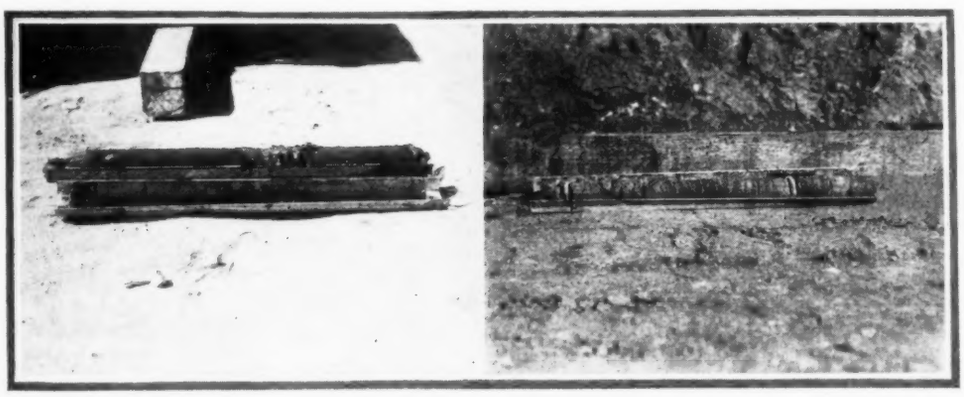
Daily Average Production

(Figures in Barrels)

	1929 Dec. 28	1929 Nov. 23	1928 Dec. 29
Oklahoma	647,550	643,050	723,150
Kansas	113,800	110,650	98,300
Panhandle Texas	102,600	102,600	59,100
North Texas	88,100	89,300	87,650
West Central Texas	54,000	56,850	53,650
West Texas	341,200	357,250	349,350
East Central Texas	23,550	17,350	21,350
Southwest Texas	74,950	74,650	36,200
North Louisiana	38,000	36,450	37,050
Arkansas	60,600	63,950	80,050
Coastal Texas	138,850	148,350	114,900
Coastal Louisiana	19,750	23,300	23,850
Eastern (not including Michigan)	128,200	118,900	111,700
Michigan	14,550	15,000	2,300
Wyoming	49,300	52,500	52,800
Montana	10,200	10,500	10,950
Colorado	5,400	5,100	6,650
New Mexico	7,700	8,000	3,150
California	689,400	699,500	708,900
Total	2,607,700	2,633,250	2,581,050

Coring Proves Valuable Adjunct *to*

NO phase of oilfield development practice has, in the last few years, shown more marked progress than that of mechanical coring. It has kept pace with modern drilling practice and is now considered a very essential part of the drilling of a deep well. Although it requires extra skill and care on the part of the driller, it does not in every case increase the cost of drilling. In the Gulf Coast District and in California, for instance, coring and drilling the hole to full size in one operation has actually been accomplished, in hard formations, at a cost per foot which compares favorably with straight drilling. With a core bit of the proper design for the type and hardness of the formation being drilled, the comparative ease and speed of drilling should be in proportion to the amount of formation actually removed by the cutting edges of the bit. In the case where a core is taken and the hole drilled to full gauge at the same time, the amount of formation actually removed by the cutting edges of the bit is less, by the amount of formation in the core, than in straight drilling. The fact that today it is possible to drill a hole and obtain a core incidental to the drilling operation, is evidence of the progress that has been made in the design and manufacture of core drilling tools used in the oil industry.



Progressive companies and operators have come to realize that coring yields positive information regarding the formations encountered and reduces the risk of overlooking likely pay horizons. Even when a dry hole has been drilled, if cores have been taken, valuable data for reference in further prospecting and development work have been obtained. By systematic coring, the nature of the strata penetrated can be accurately determined and their exact depth and thickness ascertained. To outline the variety of uses to which coring information is, and can be put, is not within the compass of this paper. It truly has been said that there is less opportunity for making underground observations in oil drilling than in any other branch of mining. No other medium offers any better opportunity for this purpose than the data obtained by coring.

Problems of Core Bit Design

The design of core barrels in common use in the oilfields today in deep wells involves a consideration of many factors, information regarding which has had to be gathered in the field under actual operating conditions. Improvement in core recovery while drilling, especially in hard formations, at a minimum cost, is the ultimate end sought. Core recovery, as used here, includes the condition in which the core is recovered as well as the percentage core recovered of that cut. An objection to the core bit in the past has been that the hole usually required reaming after taking a core. Double barrel rotary core drills as used in deep holes today, do not have this objectionable feature. When the core is being taken, the hole is drilled simultaneously to full gauge, and the necessity for reaming eliminated.

One of the most important problems of bit design is balance. A bit with proper balance has its cutting edges so disposed that there is no wabble of the bit while it is in operation. Formations vary widely in hardness and their resistance to cutting. Abrupt changes in these physical characteristics, occurring as they do, often and within short distances in the well, necessitate changing the type of cutter on the bit. Efforts have been directed with some success to overcoming these limitations by designing cutters and putting into them materials that have good inherent cutting efficiency under a wide range of conditions and for soft and hard formations. The problem of obtaining and maintaining proper balance usually is greater in the scrape type of bit than in the cone or roller rock type bit. A bit may become out of balance due to irregular wear or to improper dressing of the cutting edges. A bit devoid of any balance will, while cutting, wabble excessively, tending to break up the core and resulting in poor core recovery. Provision for preventing contamination of the core also enters into bit design. Something to prevent plugging of the core barrel is necessary. Running a core drill through a bridge in the hole is liable to result in some of the bridging material entering the core barrel. A core bit plug has been developed which is effective in preventing trouble from this source. In another bit of comparatively recent development, the design and operation is such that trouble from a bridged hole is entirely obviated. This is a combination drilling coring bit, wherein the core drill assembly is dropped down through the drill stem.

A core barrel vent has to be considered in design, to make provision for relieving the pressure on top of the core, and allowing any fluid that may have entered above the core to escape freely from the core barrel. Another point of design upon which good core recovery depends is the core catcher. The failure or irregular operation of the core catcher may render useless all other good features of the bit. These are, in brief, some of the more important features of core bit design.

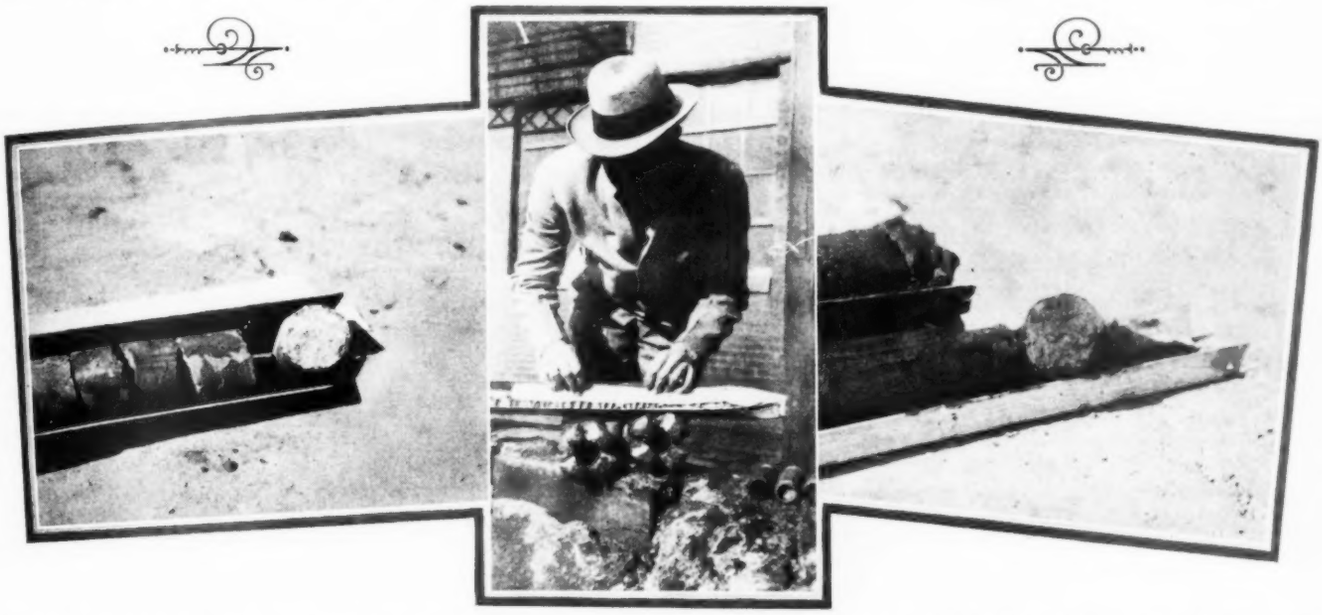
Core Drilling Difficulties

In no other operation connected with the drilling of a deep well does success hinge more on the skill and care of the driller, than in coring. Different formations require different methods of handling. Friable sand interbedded with shale requires considerable skill as well as highly developed tools for good core recovery. In soft sands the bit should be fed fast to prevent washing away the core. In

Modern Drilling Practice

By K. C. SCLATER

sticky formations, feeding the bit slowly combined with good mud circulation, gives the best results. Between the length of core recovered and the depth core drilled, usually there is a difference. Although the amount of core recovered is usually less than the amount drilled, it does sometimes happen that more core is recovered than has been drilled. This may be due to one or more of several causes. If the bit is fed too fast in certain soft, sticky formations, the mud circulation cannot carry away the cuttings fast enough, with the result some are squeezed into the core barrel with the core. Improper flushing of the bottom of the hole before starting to core may result in cuttings or heavy mud entering the core barrel and becoming compacted on top of the core proper. Some formations, bentonitic shale for example, swell when they come in contact with water, and the length of the core is increased thereby. When a core of this kind is brought to the surface, it may give a false indication of the formation thickness drilled through. Sometimes it is desired to get the exact location of a break in the formation; in a case of this kind the length of the core is not so important.



Core Drilling Methods and Equipment

Some companies make it a practice to core every break in the formation below certain depths. If a sand looks promising or doubtful, it is tested. Several operators in the Gulf Coast district do not attempt to take long cores. It is found that improved core recovery is obtained by taking short cores. In general, it is found, especially in deep wells, that short cores save much time and trouble in the long run, and give a much greater and better core recovery than long cores. For good core recovery, much depends on having the mud of proper and uniform consistency for the formation being cored. If the mud is too heavy, it slows up the work of coring and is detrimental to good recovery. The time factor in coring has to be considered. In this connection an interesting development in core drilling equipment is the combination drilling coring bit, because of novel features of design and operation which it possesses.

A recent development placed on the top of the core barrel is an acid-bottle container, so that the well can be cored and tested for verticality in the same run. A saving in labor charges, power, water and fuel costs, besides the increased revenue that will accrue from the early completion of the well, as well as more detailed information on horizons, are some economies resulting directly from coring. In one well in the Gulf Coast district, Texas, a core was taken from 7300 to 7301 in 2½ hours; from 7304 to 7305 another core was taken in 2 hours. In each case 100 per cent recovery was obtained. On four other wells in the Gulf Coast district, all within a radius of 100 miles, 281 cores were taken at depths from 1625 to 6527, the average time per core being less than 81 minutes and the average core recovery about 62 per cent. The cores taken were from 1½ to 2 feet long. This record was made shortly after the bit was introduced in the field, and before its possibilities and limitations were known. Records kept on ten other wells in the Gulf Coast district where 388 cores were taken at depths ranging from 1150 to 5800 feet showed that on each of the ten wells the average time was from 32 to 90 minutes per core, or an average for the 388 cores of about 65 minutes per core.

Records similar to these, taken from field observations, can be duplicated in deep drilling wells throughout the country. They are convincing evidence of the great strides that are being made in core drilling operations. Systematic coring records, together with records of vertical deviation, have been the means of contributing greatly to our knowledge of underground conditions. This knowledge has been invaluable in planning development work and in finishing wells in a manner that tends to decrease operating costs. As further progress is made in coring methods, a still wider use of coring is bound to follow and should further eliminate much of the guesswork regarding underground conditions that must prevail if no cores are taken. It seems a reasonable prediction that the day of more general coring, especially at great depths, is coming.

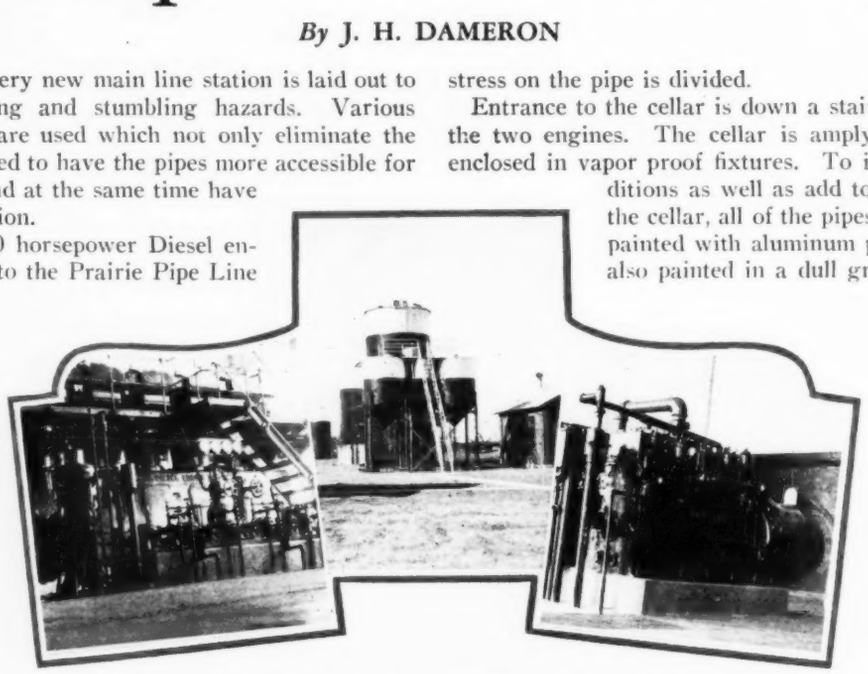
Unusual Piping Arrangement at

Prairie Pipe Line's Panova Station

By J. H. DAMERON

VIRTUALLY every new main line station is laid out to eliminate tripping and stumbling hazards. Various piping systems are used which not only eliminate the hazard but are designed to have the pipes more accessible for repairs or changes, and at the same time have them in a neat condition.

When two new 600 horsepower Diesel engine units were added to the Prairie Pipe Line Company's Panova, Oklahoma, station, the layout called for a piping system which contrasted sharply with the older method of piping in the station, and embodied many advanced features in station piping. It does away entirely with conduits beneath the floor level, and their common troubles when changes are necessary.



Left—Arrangements for small centrifugal pumps at Panova station, with centrifuge machine on the left and automatically operated sump pump on the right. Right—Direct connected generator unit at Panova. Center—Water treating (background), fuel storage, circulating water, and fuel oil tanks at Panova station. The small tank between the two fuel tanks in the foreground is used to store crude oil for starting the engines.

All of the fuel, lubricating, and water lines are located in a cellar seven feet deep, built directly beneath the two engines. Almost all of the lines extend around the cellar walls, and the walls of the engine foundation. None of the lines are on the cellar floor and only a few are overhead. This condition approaches the ideal, in that all lines are out of the way and are easily accessible for repairs or changes.

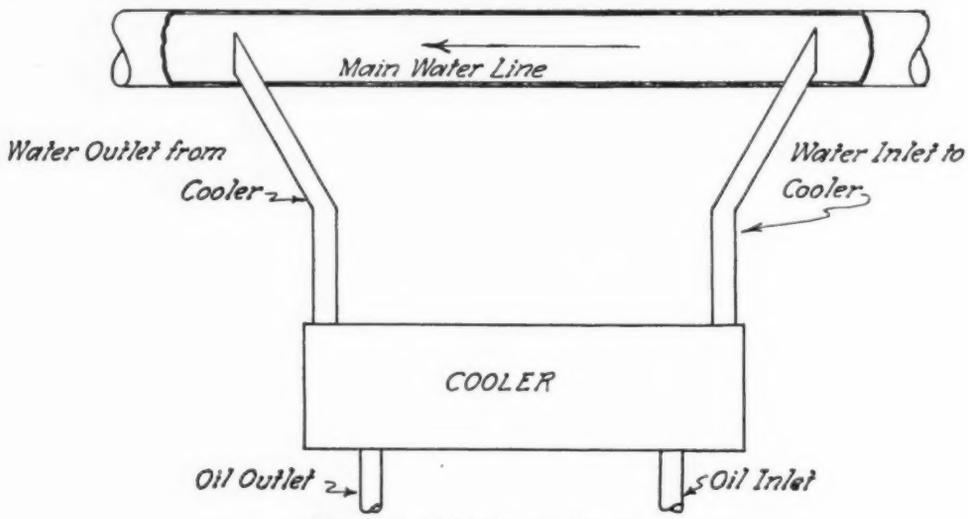
To give added support to the lines extending around the walls, small peg holes have been left in the concrete. Into these are inserted half inch pegs, and in this manner the stress on the pipe is divided.

Entrance to the cellar is down a stairway located between the two engines. The cellar is amply lighted, with lights enclosed in vapor proof fixtures. To improve lighting conditions as well as add to the attractiveness of the cellar, all of the pipes and installations are painted with aluminum paint. The floors are also painted in a dull gray, and small gutters on both sides of the wall have been cut in to carry away water from leaks or other sources. These gutters drain into a small sump in the cellar, which is kept down by an automatically operated turbine bilge pump operated by a float in the sump.

With this arrangement it is possible to heat the fuel oil lines, with the exception of a few feet, all the way to the engines with the exhaust water lines. All of the fuel oil is run through a centrifuge machine before being delivered into the main fuel tank, and before going into the engine it passes through a strainer.

Connected by a by-pass to the lubrication feed line to each engine, is a hand operated priming pump located in the cellar. Whenever the unit is shut down for any appreciable length of time, the priming pump is operated to send oil to all of the bearing surfaces before the engine is started.

One of the advanced features of the layout, is the method



Hook-up for lubricating oil after-cooler.

of cleaning and cooling the crank case oil. Oil flows from the crank case to a sump tank in the cellar, thence to a heater on its way to a centrifuge machine, and from the centrifuge machine the stream passes through an after cooler, then back to the sump tank, from which it is pumped to the overhead tank.

A flow line from the sump tank is connected to a nipple in the bottom, and through this line the oil in the bottom of the tank, and which is the most contaminated, is pumped to the centrifuge. The line passes through the heater, where the oil is heated anywhere from 140 to 180 degrees by the exhaust water, before it goes to the separator. The heater is not used during the summer months. After passing through the centrifuge, the cleaned oil flows through an after cooler to reduce the temperature. The reduction of temperature of the oil ranges anywhere from 30 to 40 degrees after going through the cooler.

From the cooler the oil is pumped back to the sump tank, where the temperature of the cool oil is raised somewhat when it comes in contact with the hot oil from the engine. The cleaner oil is pumped back to the overhead tank, and from there flows back to the bearing surfaces and completes its cycle. The suction line on the sump tank to pump the oil to the overhead tank, is connected to a nipple several inches above the bottom of the sump tank. This gives the suction line the advantage of taking the cooler oil and drawing from near the top of the level in the tank rather than at the bottom where the heavier constituents in the dirty oil would likely be picked up.

This system of continuous by-pass and of cleaning the oil, is proving more economical than cleaning the oil in batches. Curves on the quality of the oil cleaned in this manner, have a steady decline. Curves on the quality of oil cleaned in batches are not as flat, and show the oil does not last as long.

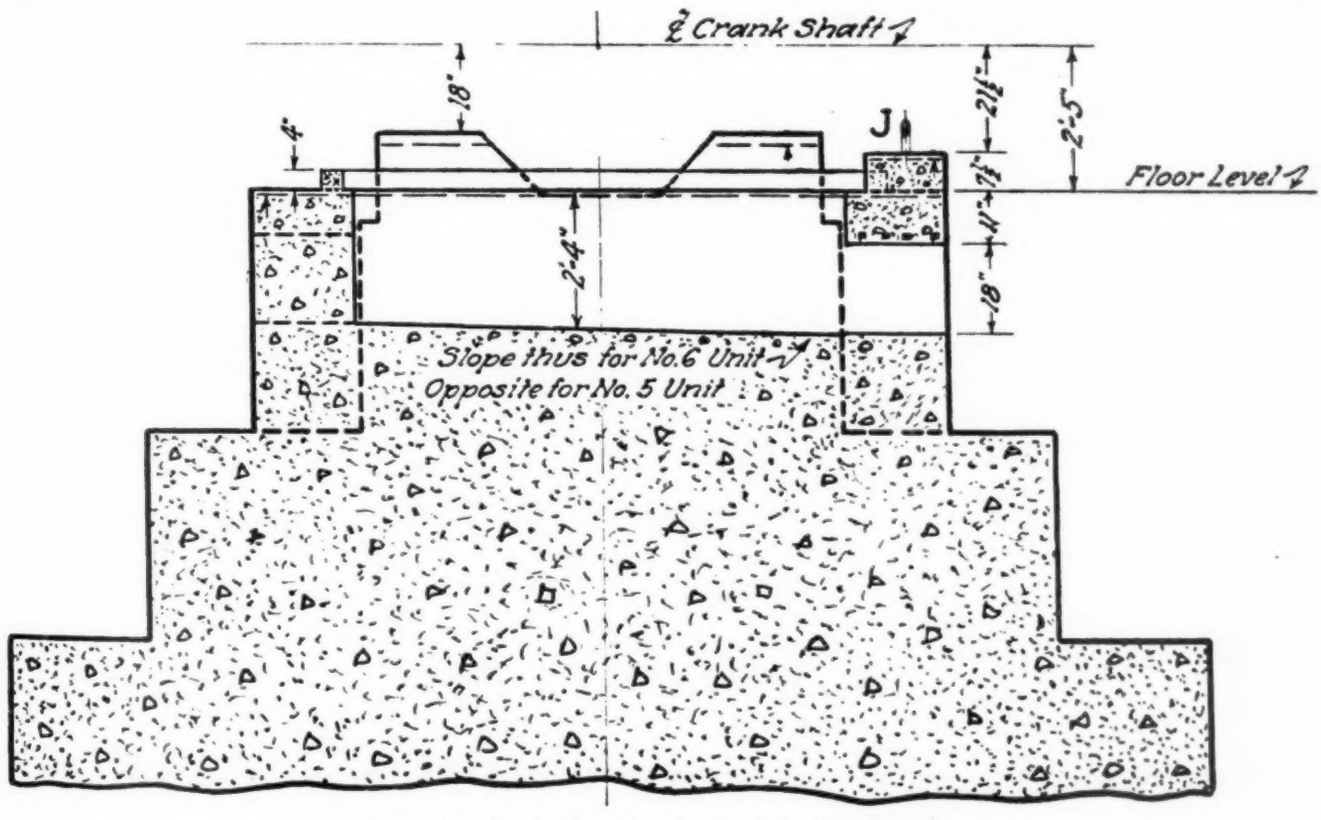
The after cooler is somewhat unique in main line oil pump stations. The cooling water for this installation is taken from the cold water line running to the engine and returned to the same line by means of a by-pass. The line leading from the cooler to the water line was cut so that it was at right angles to the direction of the flow, and then to prevent too much of an obstruction in the water line, small holes were drilled in that part of the cooler line inside of the cold water line.

To obtain a pressure differential which would insure continuous circulation in the after cooler, the discharge line from the cooler was cut so it would be at a right angle with the direction of flow, and was welded in the pipe just opposite direction to the intake line. The flow through the water line around the discharge line, eddied around the end of the discharge line and had a tendency to put a suction on the water being returned to the water line from the after cooler. In this manner, continuous circulation is obtained. While cooling the oil, the temperature of the water is raised to only a negligible degree, and does not change the temperature of the engine cooling water to any appreciable extent.

Another interesting feature of the new layout is the flywheel ventilation system. The fly-wheel is enclosed with guards. A pit was built with concrete below the floor level, as shown in the accompanying drawing, and sloped to permit oil to drain to the sump. Above the pit bottom, the opening to the concrete conduit was built. This extends on out to the cellar and the air blown through it by the flywheel goes on into the cellar.

It keeps the cellar well ventilated and cool. The draft passes on out of the building through a stack built in a corner, and which is equipped with a turbo ventilator. Although little dust will accumulate in the cellar, the circulation system keeps it fairly clean.

On the engine room floor the layout for the circulating pump is somewhat different from that of the average station.



Cross-section of engine foundation, showing flywheel ventilation pit.

All of the small centrifugal pumps in the new part of the station are set up on a concrete block between the two engines, and bring all of these units to one central point. The largest pump shown on the right end of the photograph is the circulating pump for engine cooling water. The second pump pumps from the crank case oil sump tank to the centrifuge machine, and the third pump takes the oil from the older engines in the station and pumps it to an overhead tank.

The fourth pump takes the oil from the centrifuge machine and delivers it to an overhead tank, while the fifth pump handles the oil from the sump tanks. On the extreme right end is the automatically controlled bilge pump, operated by a float, which operates in a sump in the cellar. The centrifuge machine for cleaning the crank case oil is shown on the left end of the set-up.

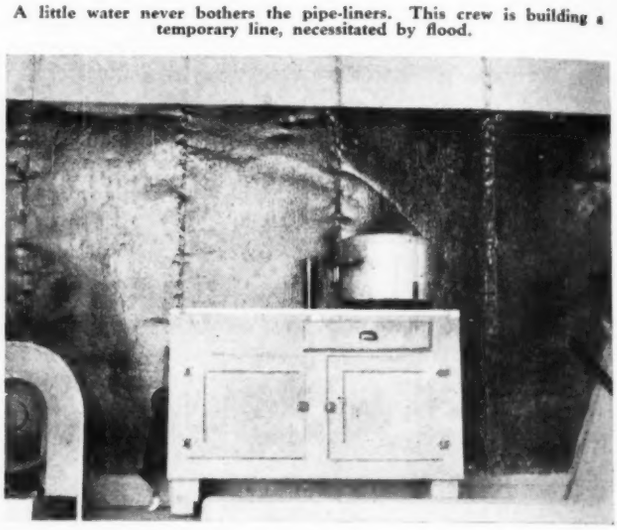
An auxiliary power unit is in a part of the new section of the station a distance away far enough to permit ample freedom of movement. This unit is a 60 horsepower Diesel engine directly connected to a 125-volt 40-KW D. C. generator, which operates at a rated speed of 800 R. P. M. A belt drive 35-KW 125-volt D. C. generator is driven by each of the large engines, and generate energy for the small pumps and lighting system.

Another construction feature of interest, but standard on the Prairie lines, is the small window in the fire-wall where the pressure gauge is located. A window is put in for each pump gauge, eliminating the bringing of any oil lines across to the engine room.

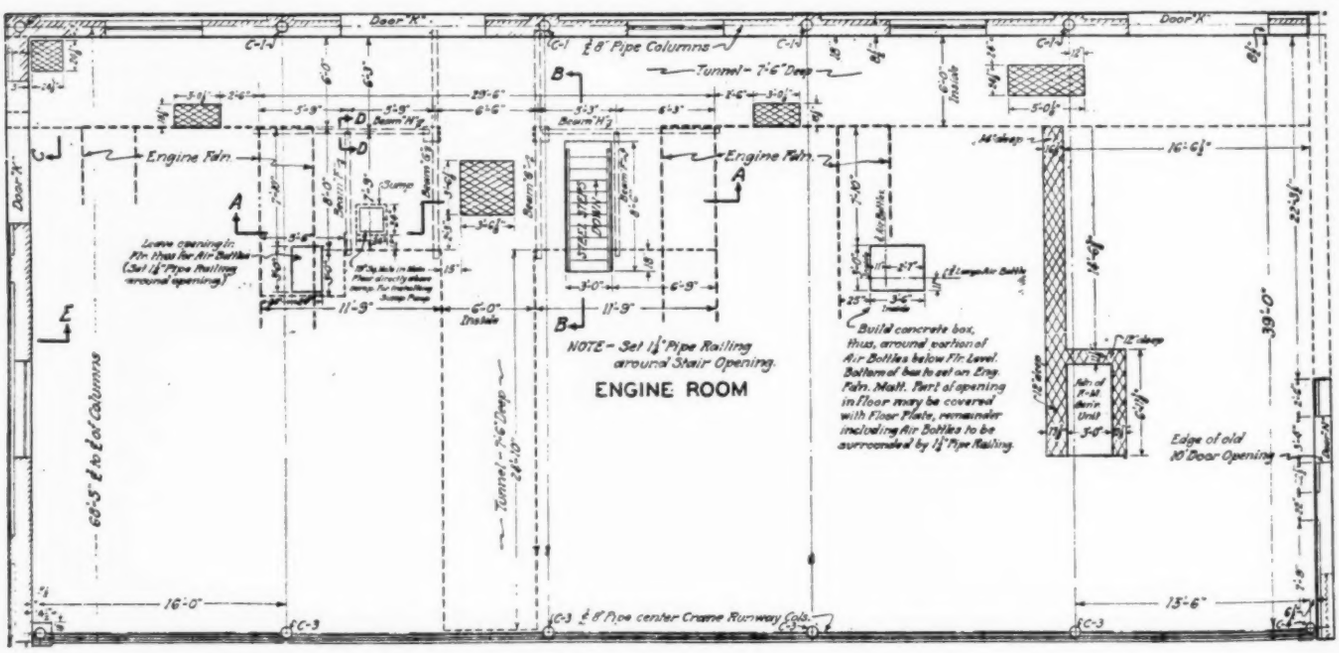
The glass is fireproof and sealed in. The gauge is set close to the glass and fastened to the wall. When starting a unit it is easy for the engineer to watch the gauge through the window and govern his actions accordingly.

The battery of water and fuel tanks, neatly painted, and some of which are on foundations made with welded pipe, are arranged in a line near the reservoir and centrifuge house. All of the water is treated in two tanks near the reservoir, and pumped to the water circulating tank directly behind the fuel tanks. The fuel oil storage tank is located between the treating and circulating tanks. After the oil has been run through the centrifuge, it is pumped to the two fuel tanks shown in the foreground of the accompanying photograph. The small tank between the two fuel tanks is used to store crude oil which is used for starting the engines instead of fuel oil.

A little water never bothers the pipe-liners. This crew is building a temporary line, necessitated by flood.



The knock-out boxes at all Prairie Pipe Line Co. stations are enclosed in the circular type guard illustrated above.



Engine room foundation and floor plan, with heavy dotted lines representing the outline of cellar, at Panova station.

Recovery of Heavy Acid Sludge

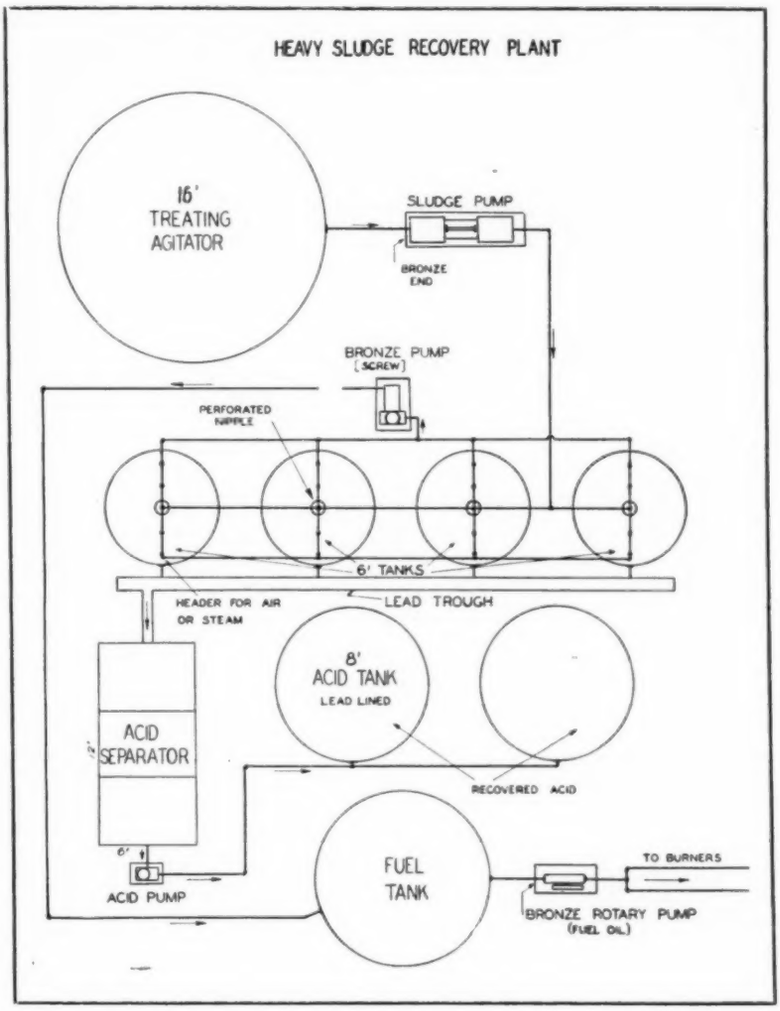
By F. R. STALEY

REFINERY chemists and engineers have devised various methods for the recovery of acid sludges produced from the treatment of lubricating distillates and cylinder stocks. In some cases the heavy sludges are permitted to solidify and then are fired to the boilers, or stills, on stokers mixed with coal or coke. The handling of the acid sludge in a solid state usually involves considerable hand labor or special equipment. In this system no attempt is made to recover any of the acid from the sludge.

Many refiners prefer to keep the sludge in a liquid state, burning it as fuel oil, or to first separate the acid. The sludge is mixed with a low viscosity fuel oil from the cracking units, or with gas oil, just as it comes from the treating agitator, without separating the acid. In the case of heavy sludges produced in the manufacture of bright stocks, when no separation of the acid is made from the sludge, a high viscosity fuel oil or reduced crude oil must be used to keep the heavy sludge in suspension. The process of mixing the heavy sludge with the oil is usually accomplished by breaking it into comparatively fine particles. The mixing kettle is usually partially filled with the fuel oil, at a temperature somewhere between 150 and 200 degrees F. It is agitated with air, while the sludge is pumped over the top through a spray head, which breaks it into smaller streams. This head is usually made from a piece of 6 or 8-inch pipe, having a plate welded over one end. The plate and the sides of this pipe are drilled with numerous quarter-inch holes, through which the sludge is pumped.

Neutralization Unnecessary

Some refiners use caustic soda or soda ash in order to partially neutralize the acidity, but this is unnecessary since an exceedingly large quantity of soda would be required for complete neutralization, and it has been demonstrated that corrosion is not serious in boilers and stills when acid sludge fuel is used, if the necessary precaution is taken to heat the unit with neutral fuel before firing with the acid fuel. Lang and Love (American Chemical Society, Minneapolis Meeting, September, 1929), have shown that corrosion occurs to a large extent only during the warming-up period due to the moisture condensing on the cold metal forming dilute acid with the combustion vapors.



Acid Recovery

When the acid is separated from the sludge to be reconcentrated, or the weak acid used for some other refinery process, for example, treating contact clay, the process and equipment necessary to handle the weaker acid and sludge fuel, is more elaborate. The sludge is pumped into lead-lined, cone-bottom tanks. Brass or bronze lines and pumps must be used to handle the weak acid and the sludge fuel. The materials and equipment for this type of installation must be carefully selected in order to minimize maintenance cost and eliminate plant shut downs.

In the case of thin sludges from treating distillates or light lubricating oils, the process of separating is simpler than for sludges from heavy stocks. In either case the sludge is pumped through a spray head into the lead lined separating tank, which is partially filled with warm water, and agitated with air. After the mixture is thoroughly agitated it is allowed to settle, and the acid which settles to the bottom of the tank is drawn off to a separator. The separated sludge is then mixed with a certain percentage of fuel oil, and pumped to a lead lined fuel tank by means of a special acid resisting pump.

In the case of heavy stocks, a process of applying acid in two pumps has certain advantages. A minimum quantity of acid is used on the first addition, and this sludge, known as the cutter, is drawn off and pumped through the spray into a separating tank, where it is mixed with fuel oil, or with separated sludge from the body acid.

The body sludge is the sludge from the second addition of acid. Due to the fact that the cutter sludge contains the smaller percentage of acid, which is usually in close combination with the organic compounds, no attempt is made to separate this acid. The body sludge, containing a larger percentage of acid, much of it uncombined, is separated similar to the procedure above outlined for lighter sludges. After the acid has been drawn off the separating tank from the body sludge treatment, this sludge is mixed with fuel oil, or with cutter sludge from the following treatment. At this point it should be noted that it is often possible to recover a certain quantity of lubricating stock from the top of the separating kettle, since the sludge separates into three layers after blowing the water mixture. The weak acid is at the bottom of the separating tank, the sludge layer in the center, and an oil layer on top. This oil layer can be pumped to a storage tank, the water settled out and then put into the regular treated oil storage.

The accompanying diagram shows the layout for a heavy sludge recovery plant. There is no lead lining in the 1000 barrel treating agitator. The 6 foot separating tanks are cone bottomed and lead lined. The suction lines on these tanks are brass, as is the discharge line from the screw pump to the fuel tank. The weak acid is drawn from these tanks into a lead trough and gravitated to a lead lined, rectangular separating tank, buried flush with the level of the ground. The purpose of this tank is to obtain a clean acid free from sludge particles. One of the important parts of the installation is the bronze pump used to handle the heavy separated sludge containing a considerable percentage of weak acid. In certain climates a steam jacketed pump must be used.

When the proper materials and equipment are used for the installation of a sludge recovery plant, a clean acid containing from 15 to 40% sulfuric acid, can be separated, and a liquid fuel that can be readily burned and handled in a liquid state, is obtained. The labor and maintenance for the satisfactory operation of the plant is minimized.

Many refineries use ordinary grades of equipment for handling the acid sludge or fuel, but whenever the sludge contains moisture, which forms weaker acid, the cost of maintenance and repairs will soon offset the additional cost of the proper corrosion-resisting metals. The connection of two dissimilar metals in contact with the weak acid, either separated or in the sludge, should be avoided since this may cause rapid corrosion due to electrolytic action.

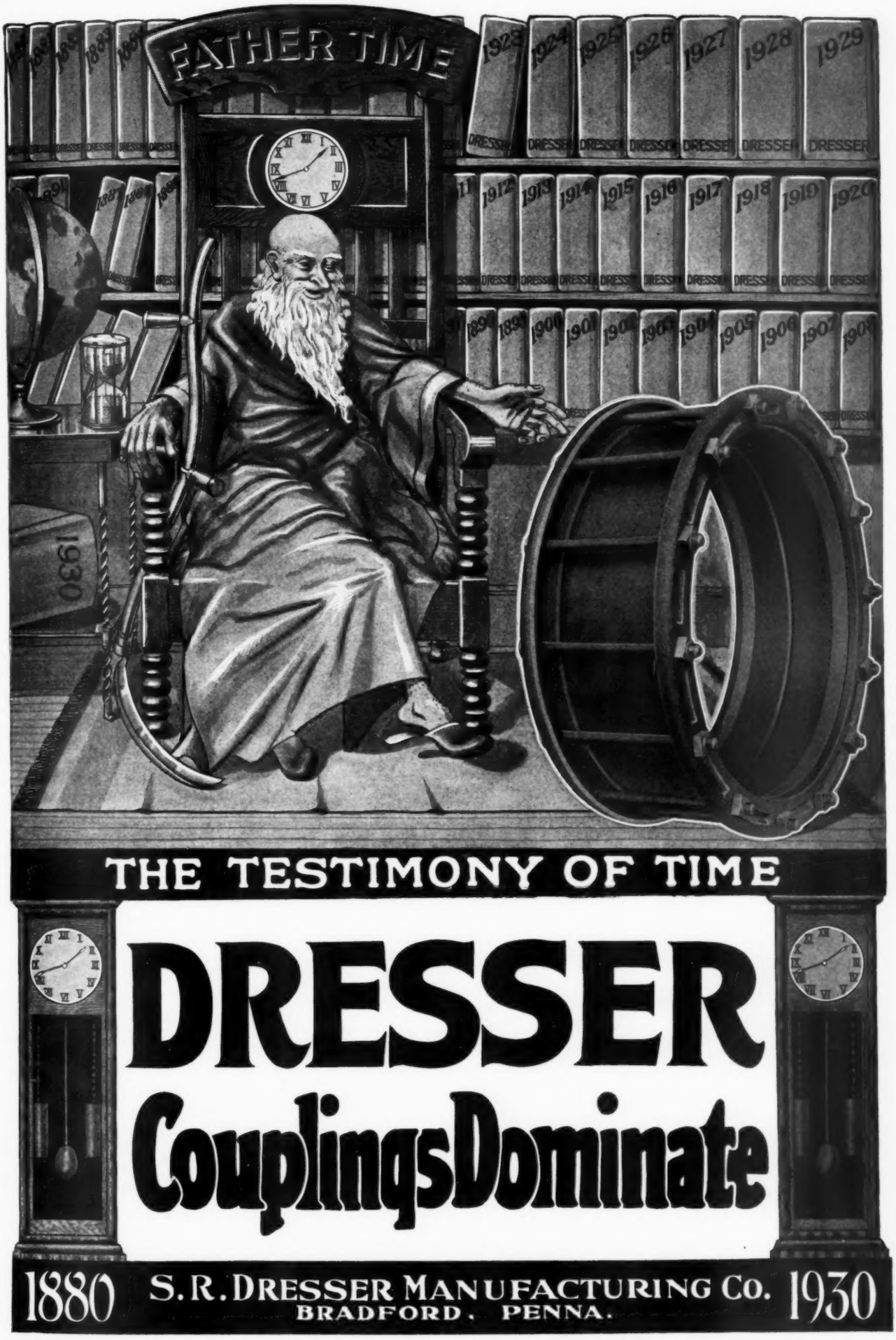
Acid resisting bronze, steam jacketed, screw pump for handling heavy acid sludge. Photograph by courtesy Quimby Pump Company.

Treating Agitator.

When the proper care is given to the separation of the weak acid from even very heavy sludges, a clean, weak acid that can be readily concentrated is obtained. Some of the larger refiners have plants which concentrate the acid so that it can be used again for treating the lubricating oils. In some refining processes a clean, weak acid can be used just as it is separated.

A very considerable saving is effected by the use of recovered weak acid for treating clay in those refineries using the contact process for filtering lubricating oils. The clay, when ground to 200 mesh, is cooked with sulphuric acid (having a concentration from 15 to 25 per cent) by steam. It, being an aluminum silicate, is converted into silicic acid, and aluminum sulphate. The aluminum sulphate is washed out with water and the clay is used on the lubricating oil either as a pulp, or is dried to a 5 to 10 per cent moisture content before using. It has been found that the clay has the same efficiency for decolorizing whether fresh or recovered acid is used provided the latter is free from sludge particles or suspended solids.

The refinery superintendent looks upon acid sludge as a necessary evil, however, many refiners have found a source of profit from sludge recovery by properly regarding it as a chemical engineering problem. After a satisfactory plant is constructed which is best suited for the particular conditions that exist in the refinery it should be operated under the proper chemical supervision. The results are that the process of recovering sludge acid is no more difficult or objectionable than many other chemical processes. Since much additional equipment is being installed for the manufacture of bright stocks the importance of sludge recovery is being stressed. Very often the problems involved in recovering acid sludge are peculiar to a given kind of oil or the processes used in the refinery, and it is necessary for the chemical and engineering departments to do considerable experimental work before the most satisfactory method is selected.



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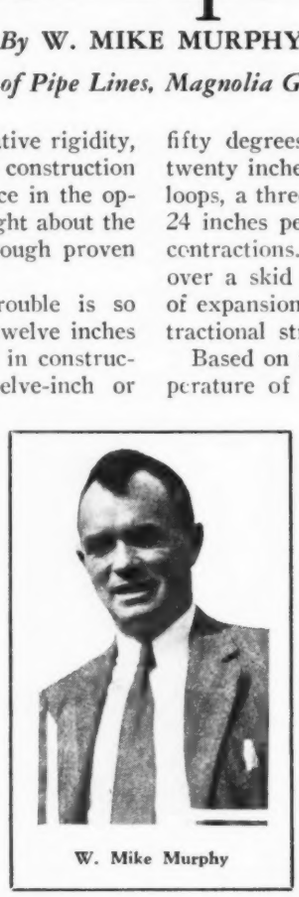
Some Observations on
Welded Pipe Lines

By W. MIKE MURPHY

Supt. of Pipe Lines, Magnolia Gas Co.

WELDED lines, because of their comparative rigidity, require a variation from the methods of construction used on other types of lines. Experience in the operation of large diameter welded lines has brought about the changes required so that they are accepted through proven service as entirely dependable.

Excepting at hazardous river crossings, trouble is so rarely experienced on welded pipe lines up to twelve inches in diameter that, with the use of ordinary care in construction, a permanent "bottle tight" line of twelve-inch or smaller diameter can be considered a certainty. Parallel lines of larger diameter using the same construction methods and laid under practically identical conditions have had trouble. The importance of engineering in construction of welded lines increases rapidly, beginning with lines larger than twelve inches in diameter.



W. Mike Murphy

As the diameter of the pipe increases, the wall thickness increases, adding stiffness to the increased weight. Above twenty inches in diameter a plain butt-welded line begins to approach the stiffness and cumbersomeness of a cast iron line. Lines larger than twelve inch, because of reduced flexibility, adjust themselves less readily to variations in the surface of the ditch. A skid, root, rock, or other high point in a ditch will often leave one or more joints "swinging" and throw the load of support of this pipe and its earth covering on the welded joint which is the stiffest point in the line. The importance of a clean, graded ditch is primary.

Unless advantage is taken of maximum contraction by early morning tie-in, on construction during summer of a large diameter line, some form of expansion joint will be required to take care of winter contraction. The stiffness of the line will not permit introduction of slack by looping more than three feet in each two hundred and fifty feet of pipe without possibility of buckling or cold bending. A three-foot loop of slack each two hundred and fifty feet of line will provide twenty-four inches per mile or just sufficient slack to equalize contraction through a sixty degree reduction of temperature. In order to take full advantage of contraction on plain butt-welded lines, it is best to first join the roll welded section into sections of approximately one thousand feet in length over the ditch, complete painting operations, lower the sections between skids each 250 feet, providing four loops of slack for each section and leaving the open ends overlapping adjoining sections on top of the ditch for the final "tie in" weld to be made and slack loops to be lowered before sunrise in the morning. To take advantage of compression, lowering should be started at the lowest point in each section, continuing up grade and leaving the open ends for final "tie in" near the top of the slope, if possible. By handling "tie in" and lowering in this way, from ten to thirty inches of additional pipe can be secured per mile.

In Texas, the temperature of pipe in an open ditch at night will seldom exceed 85 degrees and in winter, under twenty inches of covering, the temperature will not be less than 35 degrees. Assuming a temperature difference of fifty degrees, the theoretical contraction per mile will be twenty inches. Assuming circular arcs formed by the slack loops, a three-foot loop of slack each 250 feet would provide 24 inches per mile, or slightly more than enough to offset contractions. If the stiffness of the pipe prevents looping over a skid on top of the ditch each 250 feet, some form of expansion joint is required to protect the pipe from contractional strains.

Based on the theoretical elasticity of steel, a drop in temperature of 60 degrees would produce in a line formerly free from stress a tensile stress of 12,000 pounds per square inch. If the stress is equally distributed throughout the circumference of the pipe, this should not be sufficient to cause failure of a perfect weld in a line where working internal pressures produce a stress less than 20,000 pounds per square inch.

The distance slack will travel from a compressed section of a line or from a flexible bend to relieve tension can not be definitely estimated. It apparently decreases in relation to the increase in the diameter of pipe. It is, of course, greater in loose backfill than in packed earth. There is evidence of travel as far as five hundred feet in clay soil in a straight run of sixteen-inch pipe and evidence of no relief as close as one hundred feet in sandy soil. A large diameter pipe manufacturer is laying an experimental line a half mile in length this year to secure information along this line.

"Tie-in" or "bell-hole" welds are generally weaker than rolled welds. For this reason, bell-hole welds should be made, if possible, where there is a certainty of equalizing stresses throughout the circumference of the pipe, and, where the stresses would be less than the average in the line. This suggests that the bell-hole welds should be placed in a straight run of pipe not closer to a bend than thirty feet.

It is often stated that if there is a break in a welded line that the broken weld was inferior. Complete breaks in welded lines occur very seldom. Examinations of cracked lines often have shown the part of the joint cracked to have been quite satisfactorily welded. This would indicate that the stresses on the pipe were not equal throughout the circumference.

Bends are particularly good for welded lines to relieve tensional stresses, especially those produced by lowered temperature; provided that the ditch has been properly graded, so that the movement of the bends will not throw unequal stresses on the welded joints. The major portion of breaks in welded lines occur near bends. At these points the stresses are more likely to be unequally distributed. Near the overbends the cracks occur in the top of the weld, near sags in the bottom of the weld, and near side bends on the outside of the bend. In ditching, particular care is required for the grading of bends to reduce the movement of the pipe near the bends which will throw unequalized stresses in near-by welds.

Overbends, after lowering, should have sufficient clearance under the bend between the pipe and the bottom of the ditch to permit contraction. The overbend should be buried sufficiently deep so that it will have enough earth covering to hold the bend in compression and prevent movement by expansion.

The outside of side bends should rest firmly against a solid side wall of the ditch. If the earth is loose, blocking behind the bend should be provided. Sufficient room in the ditch should be allowed on the inside of the bend to permit the contraction of the bend to relieve tension.

Sags should rest firmly in compression against a hard ditch bottom to hold the sag in compression when expanding. It is an advantage for sags to be buried shallow to permit movement for the relief of tension.

Wye connections to a welded line are points of weakness unless carefully reinforced. Here the elliptical cut has more area than the cut of a tee connection. The stresses on the weld are unequal. The greatest stress being along the line of the major axis of the weld and the least along the minor axis of the weld. The crotch of the weld being along the major axis is one of the points of greatest stress. Normally this should be the weakest point of the weld, because of the difficulty of securing complete penetration at this point. Thrust of either line, or a parting movement will add additional excessive stress on the weld. Any abrasive substance in the gas or oil stream, such as fine sand, has a tendency to cut at the point projecting in the pipe at the crotch of the weld. Wye connections which have stood satisfactory tests may be expected to fail in time during operation.

Angle or mitre welds in a line are liable to produce trouble. A greater stress is produced on the angle weld than on a girth weld by internal pressure, because of the greater area of the elliptical cut in the angle weld. Any contraction of the line on either side of the weld will throw an excessive tension on the crotch of the weld which is its weakest point.

Blocks should be placed on the opposite side of the line from all openings. The opening of a valve on an outlet will produce a movement of the line on the opposite side from the outlet, unless the line is properly blocked at this point. Any movement of the line will cause a strain on the outlet weld or on the girth weld of the line on either side of the outlet. If possible, on long lateral lines "Wollops" or long bends should be placed in the line at least one joint away from the outlet connection to relieve the line from thrusts on the outlet.

Quick variations in temperature are more harmful to a welded line than greater variations applied slowly. Failures in welded lines practically never occur where the line is buried in a swamp or under standing water. The greatest number of failures occur where the line is buried under well-drained sandy soil. Breaks seldom occur in a welded line buried below the frost line, while the surface of the ground is frozen. When snow or frozen ground commences to thaw is the time when trouble can be expected in well-drained sandy soil. The soil around the pipe is comparatively dry when the earth begins to thaw, and the cold water trickles through the sand, striking the pipe and causing a quick reduction in temperature. The packed wet sand prevents the pipe from adjusting itself quickly to the contractional strains.

The deeper the pipe is buried, the less harm can be done by a quick thaw. It is a particular advantage for pipe to be buried deeply in sandy soil. The same condition applies in well-cultivated land where the thawing ice or snow penetrates to the pipe quickly. A well-mounded backfill with a

Four scenes showing construction of welded pipe lines. The right-hand illustration shows a typical Louisiana swamp which had to be crossed.

sod covering, where permissible, is of value for turning the water away from the line. A waterproof insulating coating on the pipe is valuable.

Welded lines are particularly advantageous in swamps, lakes or other places under standing water. The changes in temperature at these points are slower and the ground is sufficiently soft to permit the line to adjust itself to such changes. Welded lines should be safer in a climate where the surface of the ground is frozen throughout the greater part of the winter than in a climate such as Texas where temperatures vary quickly and where there are many freezes and thaws each winter.

An all-welded line without expansion joints contains no relief for torsion. Where a bend is lowered in the ditch without care being taken to lower pipe on each side of the bend at the same time, a twist will be thrown in the line in the direction of the bend. In the same way, if a line is laid over the ditch sinuously for slack, the ditch following the continuous line of the chords of the horizontal slack loops, when the alternate slack loops are raised and lowered in the ditch they will produce opposing twists or torsion in the pipe. For this reason, particular care should be exercised in lowering bends, large pipe should be laid over the ditch, and slack placed in the line vertically by loops of slack resting alternately on the bottom of the ditch and on the skids at the top of the ditch. An all-welded type of expansion joint which will relieve torsion is the Lege flexible expansion joint which operates to relieve strains through multiple convolutions.

Rust streaks in fractured welds have shown evidence of small cracks existing in welds for a long time before they failed. These cracks can be caused by rolling sections of pipe off skids or dragging welded sections before the welds have cooled.

With a maximum stress of less than eighteen thousand pounds per square inch produced by working pressures of the line and a maximum contractional stress of twelve thousand pounds per square inch, the elastic limit of the metal in an eighty per cent perfect weld would not be exceeded unless the line were carelessly ditched, bends improperly placed and blocked or stresses introduced in the line by improper handling during tie in, lowering, testing, and other operations before covering. An ideal condition for construction would be one in which the temperature during construction would be that of the minimum temperature of the pipe in the ditch in winter and the pipe roll welded in the ditch so that on completion of the roll welds the pipe would be in a position requiring no movement in preparation for tying in. Rough handling is bad for a line regardless of its type of construction. When a welded line is hoisted and lowered slowly, conditions of stress in the line will be similar to conditions at the same points in a suspended uniformly loaded flexible beam. The welds being stiffer than the pipe, stresses in welds in a line hoisted or dropped quickly will approach those in a cantilever beam under vibrating load. Satisfactory welds can be permanently damaged by stresses exceeding their elastic limit in rough handling and there is no certainty of all the weak welds in a line being discovered by abuse.

CALCULATION OF SLACK IN A THREE-FOOT LOOP EACH 250 FEET OF PIPE—

$R^2=(R-36)^2+(1500)^2$

$72\,R=2251296$ inches

$R=31268$ inches

Circumference$=2\ \text{pi} \times 31268$ inches

$=2 \times 31268 \times 3.14159265359$

$=196462.6382421$ inches

$$\text{Sin } A=\frac{1500}{31268}$$

Referring to "Logarithmic Tables," by Baron Von Vega:

Log Sin $A=3.1760913-4.4951001$

$=8.6809912-10$

$A=2°\ 44'\ 58.811''$

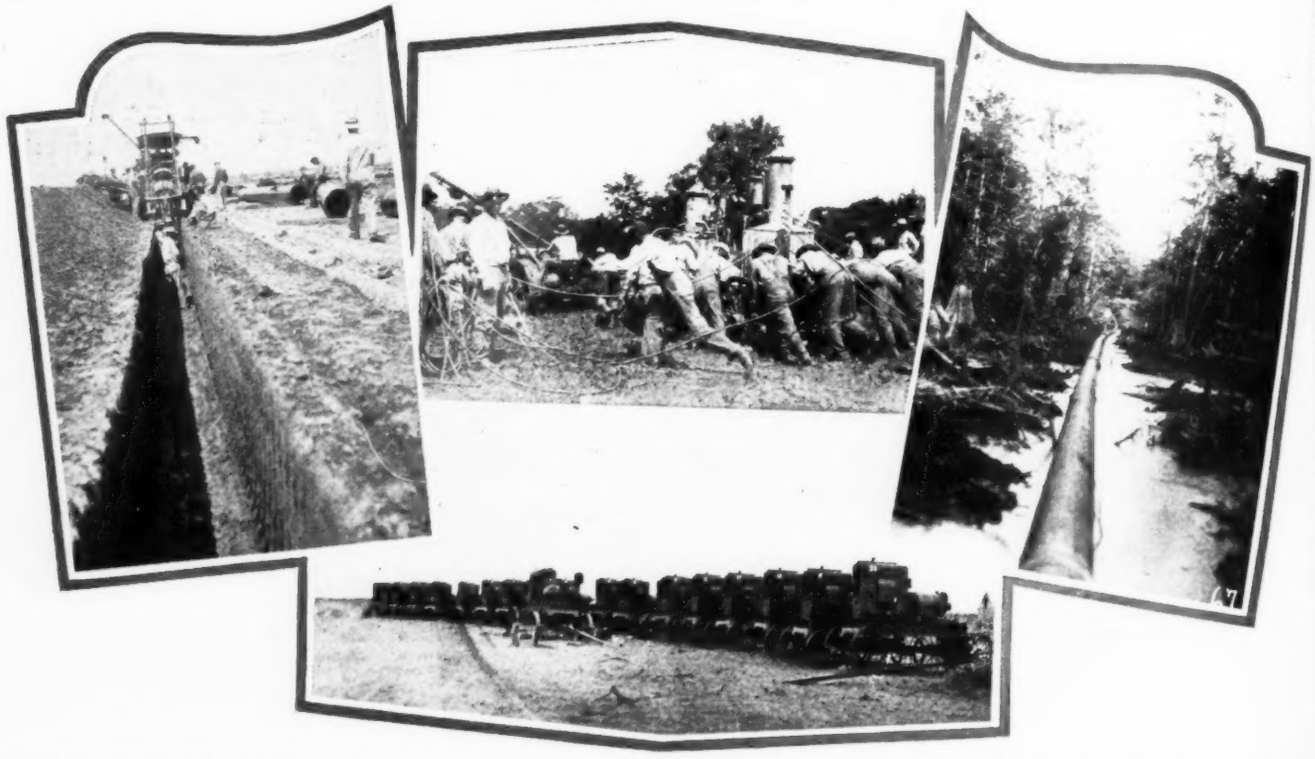
$=2.74967°$

$$\text{Length of arc}=\frac{5.49934 \times 196462.6382}{360}$$

$=3001.152$ inches

Slack per 250 feet$=1.152$ inches

Slack per mile$=24.33$ inches



Top, left—Digging ditch for a modern pipe line. Center—Manpower still has its uses. Right—In the swamps—and how! Below—A battery of generators.

Special Equipment Necessitated for

World's Deepest Producing Well

WHEN the world's deepest producer, Texon Oil & Land Co.'s 8,523-foot pay zone discovery well in the Big Lake pool of Reagan County, Texas, was completed, all of the oil-saturated timber on the derrick offered a great fire hazard. To eliminate this hazard all of the timber was removed and the bolted housing shown in the accompanying photograph was built.

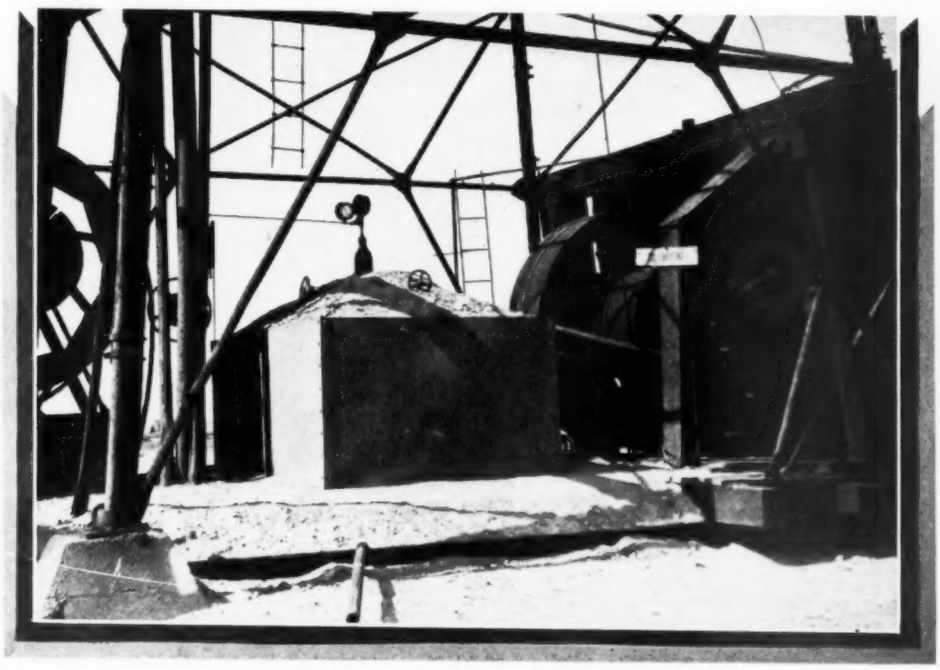
Originally the derrick floor was 2-inch plank, the framework two by fours and the roof built with 1-inch plank. There were several reasons the frame housing and floor were not desirable and, to give the connections protection from wide changes in temperature as well as protect them from the weather, the housing was filled with gravel and sand.

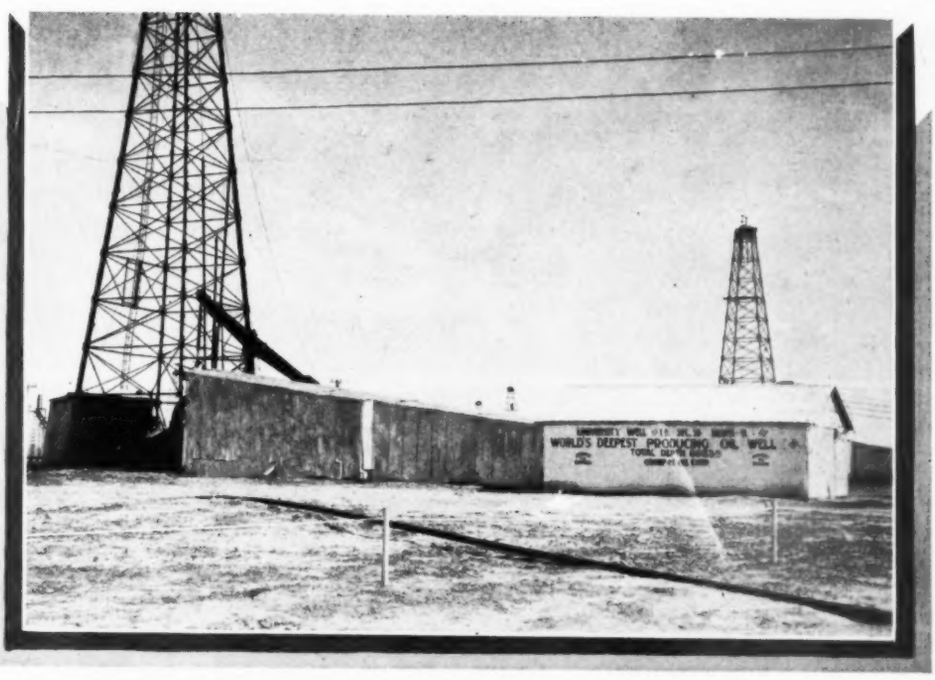
This well pioneered the way for deeper drilling in West Texas. It started out making only 40 barrels daily, but production steadily increased and the well is now producing around 2,900 barrels of high gravity oil daily. The oil is mixed with the crude produced from the regular 3,000-foot zone in Big Lake, which is much lower in gravity.

Since the completion of the deep producer two other wells have been drilled to the deep pay. However, neither of these wells has established the auspicious record of the discovery well. Several other wells are being drilled to 8,500-foot zone.

In the drilling of the Texon Oil & Land Co.'s discovery well in the Big Lake field, just as in putting down deep wells in the other pools now under development, such as Kettleman Hills in California, and Oklahoma City, all machinery and equipment used was called upon for extraordinary performance and its sturdiness was subjected to most severe tests. In these deep fields special hook-ups and equipment will probably become general, and will very likely be designed to meet specific conditions as they are encountered.

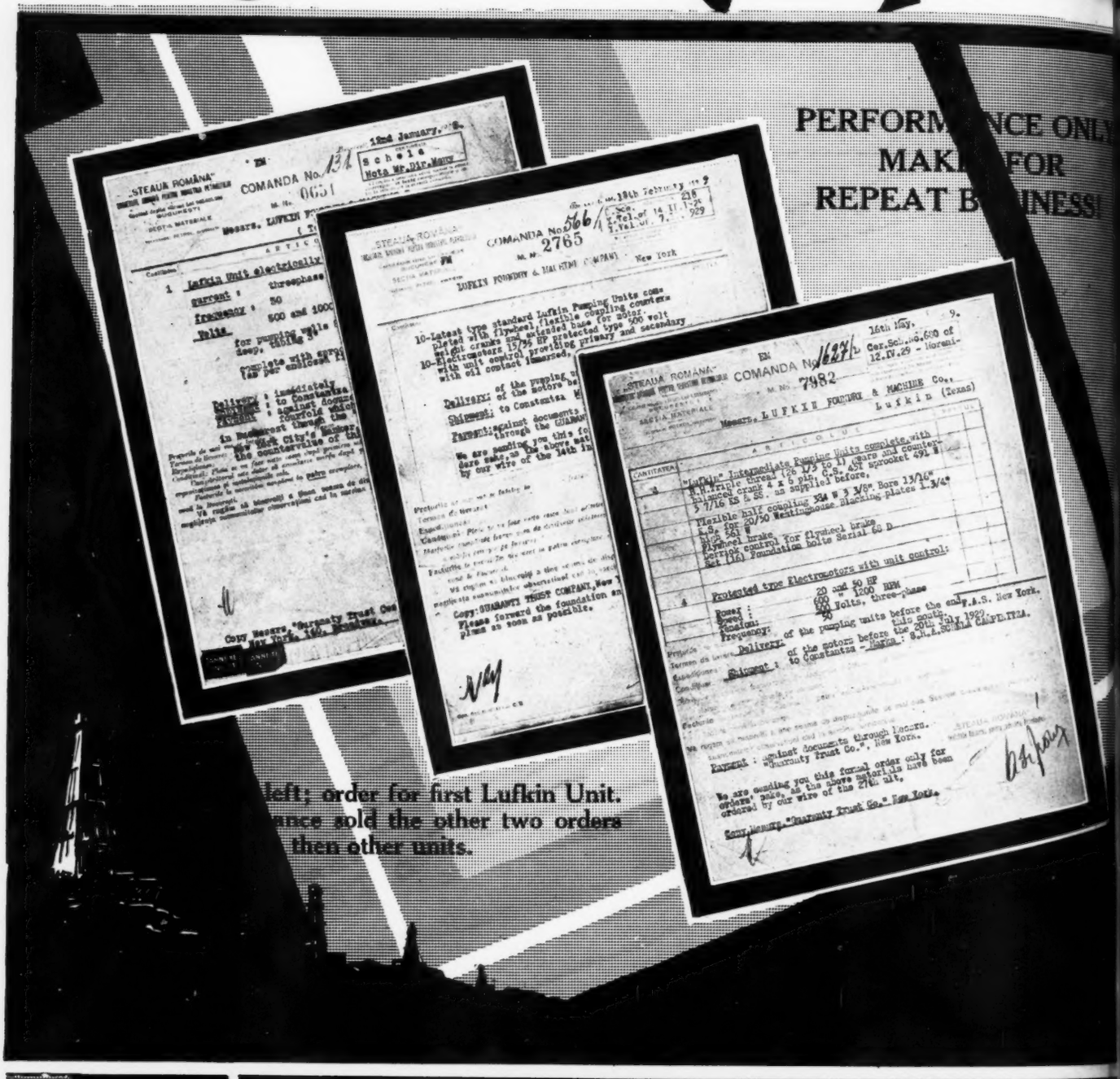
One phase of handling deep production which is now claiming much attention is the matter of grouping the stock tanks in a central location and using longer lead lines. It is reported that the operators in the new Kettleman Hills field of California are considering this procedure, and also are considering using meters to measure the output of the individual wells. Irregular surface conditions with consequently heavy transportation costs are said to be responsible for this measure.





Top—Detailed view of housing filled with sand. Bottom—View of world's deepest producing well

Lufkin Equipme



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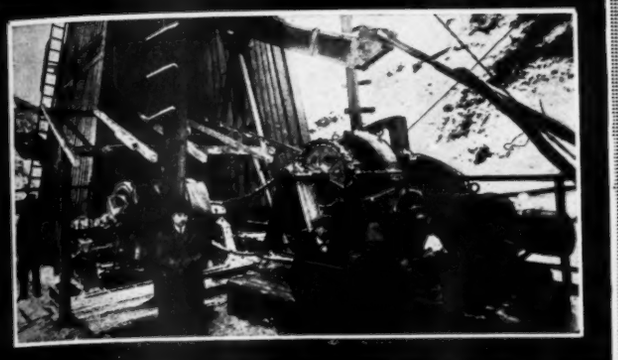
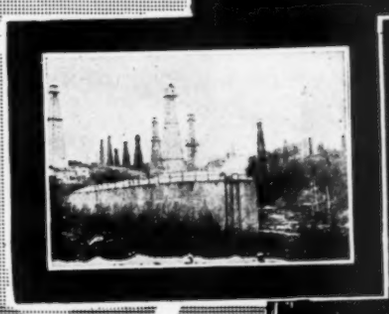


...ufkin Units in the Moreni Field in Rumania

...pictures tell the story. The first order from the "Steaua Romania" came ...t inquiry—merely stating well conditions and power available. A suit... Lufkin Unit was furnished including auxiliary equipment. The pictures, ...right, show installation about completed of the initial equipment . . . to the ...t are the orders that followed and since that time have come ...ese orders. The *repeat orders* followed *performance* as a nat... ...ral sequence.

Some idea of the rough rugged terrain of the Moreni field, to which Lufkin Units are particularly adapted, can be gained from the views of the field, lower right.



...BACK OF REPEAT BUSINESS MUST BE PERFORMANCE ...IS THAT THING THAT KEEPS LUFKIN UNITS ...VANCE OF THE FIELD.

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...Y AND MACHINE CO.

TEXAS.

Okla. Houston, Texas.

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Gas Company Utilizes

Line Pressures for Flowing Wells

TO approach the minimum in lifting costs to pump the water wells at its Latex (Texas) gas compressor station, the Magnolia Gas Co. is flowing its wells with the gas from the suction line and then using the gas for fuel to run the engines. The water is flowed through a shop-made separator, details of which are shown in the accompanying drawing.

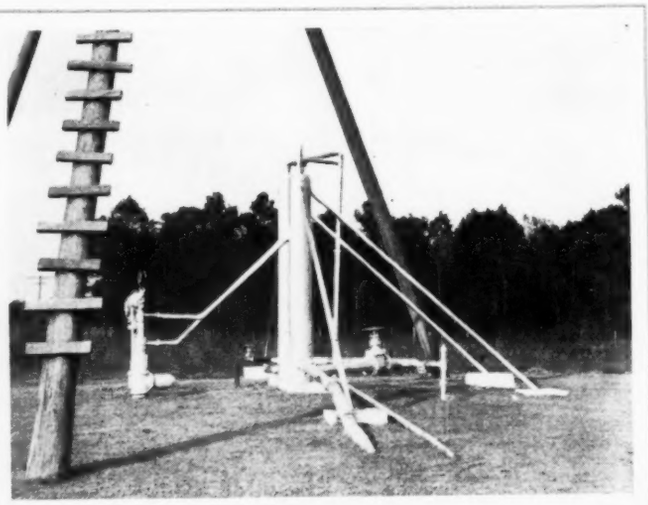
The transporting company has 12 wells to produce, some of which are half a mile from the station. The producing water sand is encountered around 150 feet but the wells are usually drilled about 40 feet deeper. Each well is started with a 12-inch hole and 6-inch casing set on top of the water sand. The bottom of the hole is packed with gravel. Each well will produce about 35 gallons per minute on an average.

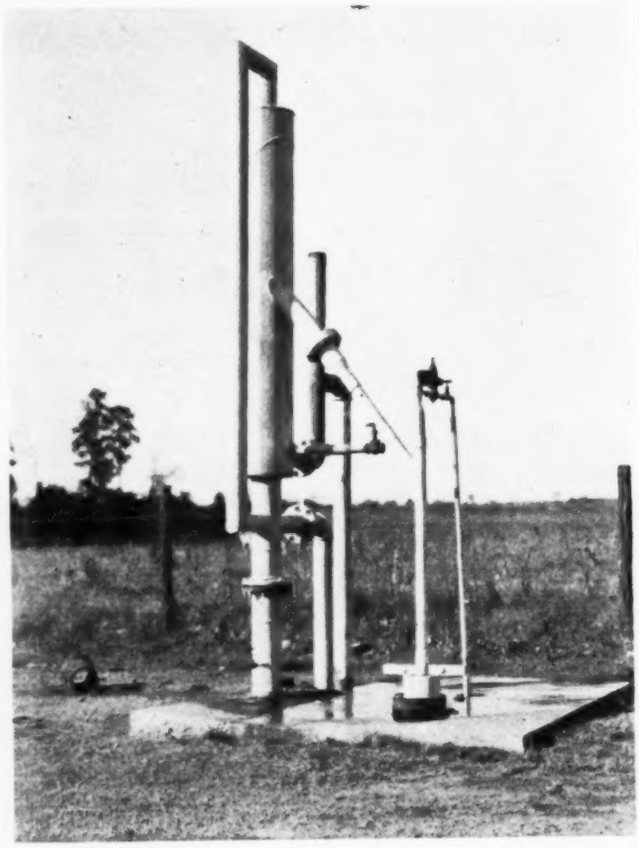
Each well is tubed with 3-inch pipe and a string of ¾-inch pipe is run to flow the gas into the well. Gas from the suction line is put in the well at about 42 pounds pressure. Each well is equipped with a regulator and a valve for pinching down the gas input. Before the gas reaches the well it is measured through a fuel meter.

Gas and water flow back to a separator and into it through an opening on a tangent at an angle with vertical. This gives the water a swirling motion in the separator and virtually all of the water is separated from the gas when it strikes the baffle plates in the top of the separator. What little water remains is knocked out when it strikes the baffle on the bottom as the gas travels on to the fuel manifold. What water is caught here drains off through a 1¼-inch nipple on the bottom of the set-up.

Most of the separator is constructed in the company's shops. The main shell is made with 12-inch pipe. The baffles in the top are inserted after slots have been cut in the shell with a torch and are then welded in place from the outside.

The shell rests on a foundation made with 6-inch pipe and which is set in a concrete base. The installation is made more rigid by the lines connected to the separator.





Two types of hook-up for flowing shallow water wells to supply compressor stations with water.

Reserve Natural Gas Co. (Cities Service Subsidiary), flows its two water wells at its Sterlington, Louisiana, compressor station in a similar manner. The deepest of the two wells is 450 feet and the other well is 180 feet deep. Each well is tubed and half-inch pipe was run inside the tubing to send the gas into the well. Gas is put into the deepest well at 52 pounds pressure and at 40 pounds pressure in the shallower well. Whenever it is desired to use the water for domestic purposes at the plant air from the air jammer is used as a lifting agency. This is done because the water produced by gas-lift had an unpleasant taste.

Both wells flow into individual separators which have only one baffle plate in the top and which has been sufficient thus far. The separators are arranged so that both wells can be flowed together or separately and by this arrangement it is possible to produce one well on air for water to be used in the cottages and the other by gas.

The separators are set on a concrete foundation and in addition to the bracing received from the well connections 2-inch pipe set in concrete is used as supports on three sides. Each well is equipped with a pressure gauge.

The water flows from the separators on down to the cold water well near the engine room where it is picked up by the small centrifugal pumps operating off the

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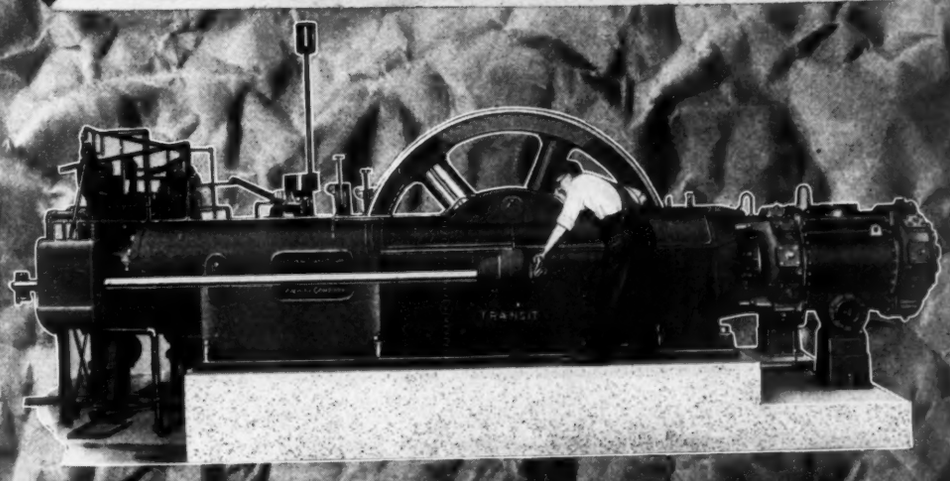

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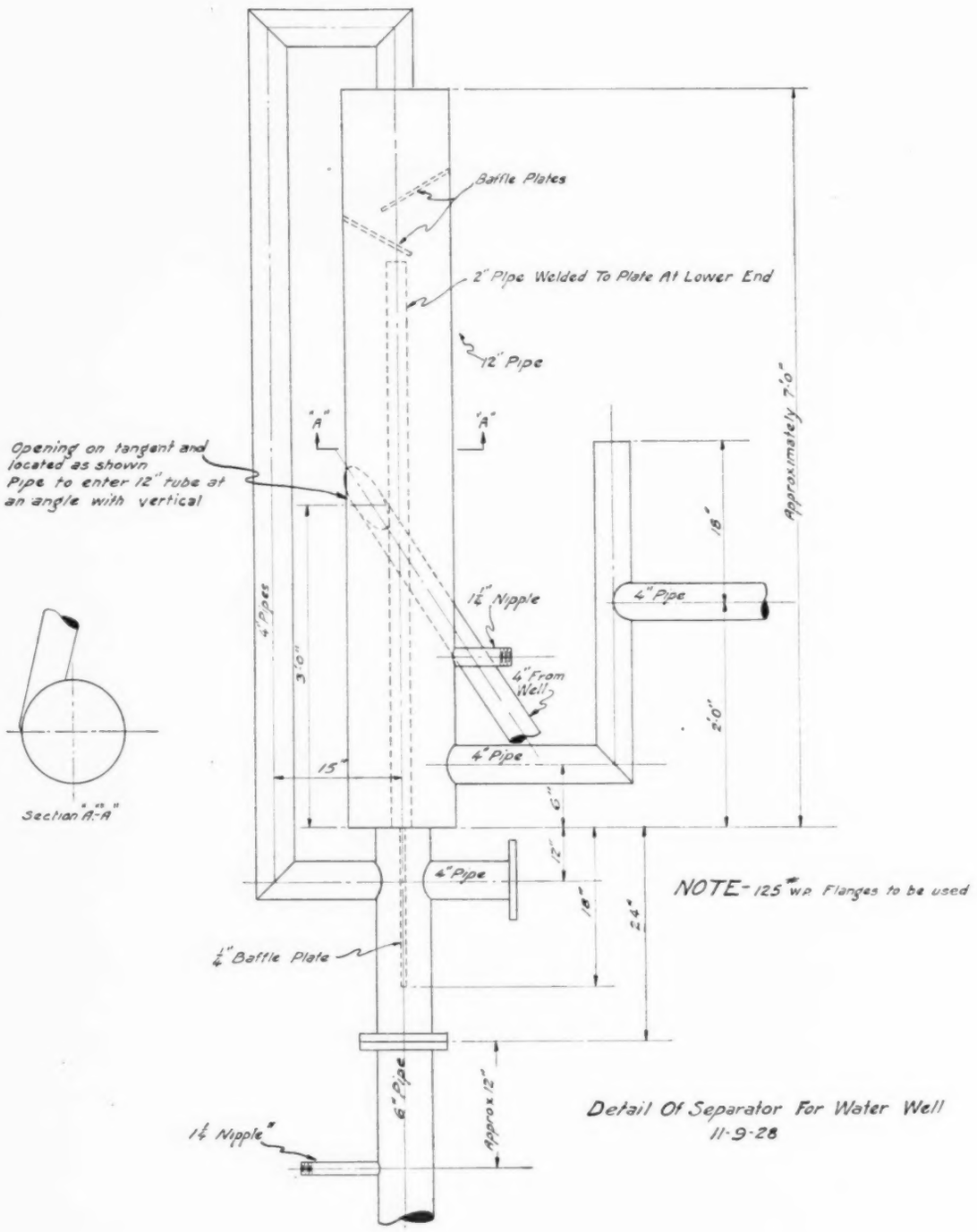

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Results of an Examination of

Diesel Cylinder Surfaces

By JOHN M. McGREGOR

WHILE considering the condition of the surfaces of the cylinders of a Diesel engine it is generally conceded that it is not alone the cost of renewals when new liners and rings are necessary that enters into the question, but also the time lost due to the unit being "down," loss of power before the engine repairs are made, and losses from many other sources that are directly traceable to worn out rings and liners.

Over a considerable period during which time a large number of checks have been made, it has been found that the variation in wear is large and it was decided that a check more thorough than those previously taken should be made and studied.

A vertical engine having four cylinders of 15-inch bore was selected. There was no particular reason for the choice other than the usual inspection period had arrived.

In making checks, in order that they may be accurate, a gauge in the form of a "T" Square is used. This gauge is dropped into the liner, the top portion, or "T," resting on the upper face of the cylinder. Holes are drilled at points along the vertical portion of the gauge, and the check is made by means of a micrometer, the point of which rests in the holes. It might be mentioned that the checks made during this particular test were taken by one man and re-checked by another, and at no time did they vary more than .001 inch.

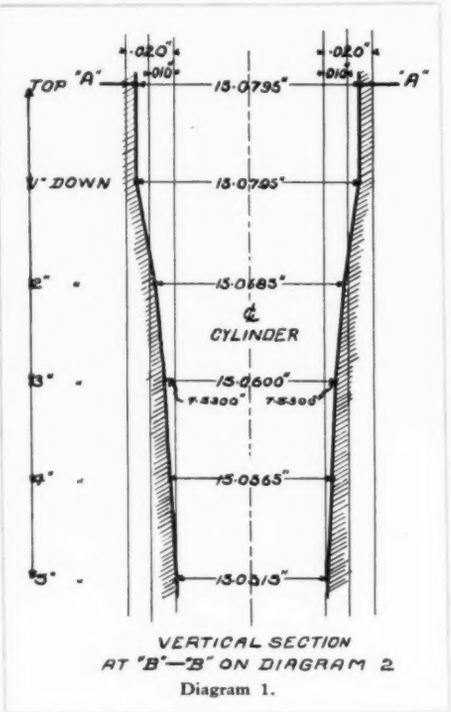

Diagram 1.

As noted in a previous article on this subject, when making comparative checks, the liners should be as near the same temperature as possible in all cases. If this be not possible the micrometers should be brought to the temperature of the work by letting them rest on top of the cylinder for several minutes before checking is commenced. The check must be made with the same instruments or by instruments that have been tested for similarity, as a fairly wide variation has been found in this direction; and further, checks must be made at exactly the same point each time, which can be done by means of marking the top of the liner and the simple jig mentioned earlier. The necessity of care in this direction will be readily understood by glancing at Table No. 2.

Measurements were made on all four cylinders at points corresponding to Zero degrees (above center line of crank shaft at fly wheel side), 45, 90 and 135 degrees, measured in a clock-wise direction. On three of the cylinders measurements were taken at points between those enumerated above. Starting at Zero, the top of the cylinder was marked off every fifteen degrees, the cylinder having a bore of 15 inches, the distance between the points measured would be approximately 1.96 inches. There was quite a variation even between points so close together; in one case, that of cylinder No. 4, at a point 4 inches below the top of first ring travel, there was a difference of .014 inch. At each fifteen degrees measurements were taken at six points down the liners, the first being at the top of the travel of the top ring and thereafter one inch down in each case. In all, seventy-two measurements were made in each of the three cylinders thus checked.

Table No. 1 shows the measurements taken at 0, 45, 90 and 135 degrees on cylinder No. 3. Table No. 2 shows the measurements taken every fifteen degrees around the top of the liner of the same cylinder at a point corresponding to the top of the travel of the leading ring.

The diagrams, although greatly enlarged to show the wear, give an idea of the shape of the liner. Diagram No. 1 is a vertical section of cylinder No. 3, the figures corresponding to first vertical column of Table No. 1. The section is made through the liner at a point 0 degrees-180 degrees. Diagram No. 2 gives an exaggerated idea of the shape of the liner in plan at section "A-A" along top of first ring travel.

In order that a comparison may be made a diagram shown as No. 3 is included. The engine from which these measurements were taken is a two-cycle unit.

It will be noted that the wear of the four-cycle unit is different, commencing at the top with .0795 inch and tapering gradually to a point five inches down where the wear is .0515 inch. This character wear is not noticeable in the two-cycle engine as shown in Diagram No. 3. In this case the least wear is shown at the top, gradually increasing until at a point four inches down there is a difference in wear of .039 inch after which it gets less, giving the cylinder a barrel-like shape. It is not known if this is characteristic of all two-cycle engines.

TABLE No. 1

MEASUREMENTS OF CYLINDER No. 3

	0°	45°	90°	135°
Top	15.0795″	15.0620″	15.0655″	15.0600″
1″ Down	15.0795″	15.0600″	15.0645″	15.0640″
2″ "	15.0685″	15.0535″	15.0530″	15.0580″
3″ "	15.0600″	15.0510″	15.0480″	15.0525″
4″ "	15.0565″	15.0505″	15.0470″	15.0525″
5″ "	15.0515″	15.0475″	15.0465″	15.0490″

TABLE No. 2

MEASUREMENTS OF CYLINDER No. 3

	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°
Top	0795	0690	0650	0620	0660	0685	0655	0625	0620	0600	0695	0775

(In second table the figure fifteen and decimal point are left out.)

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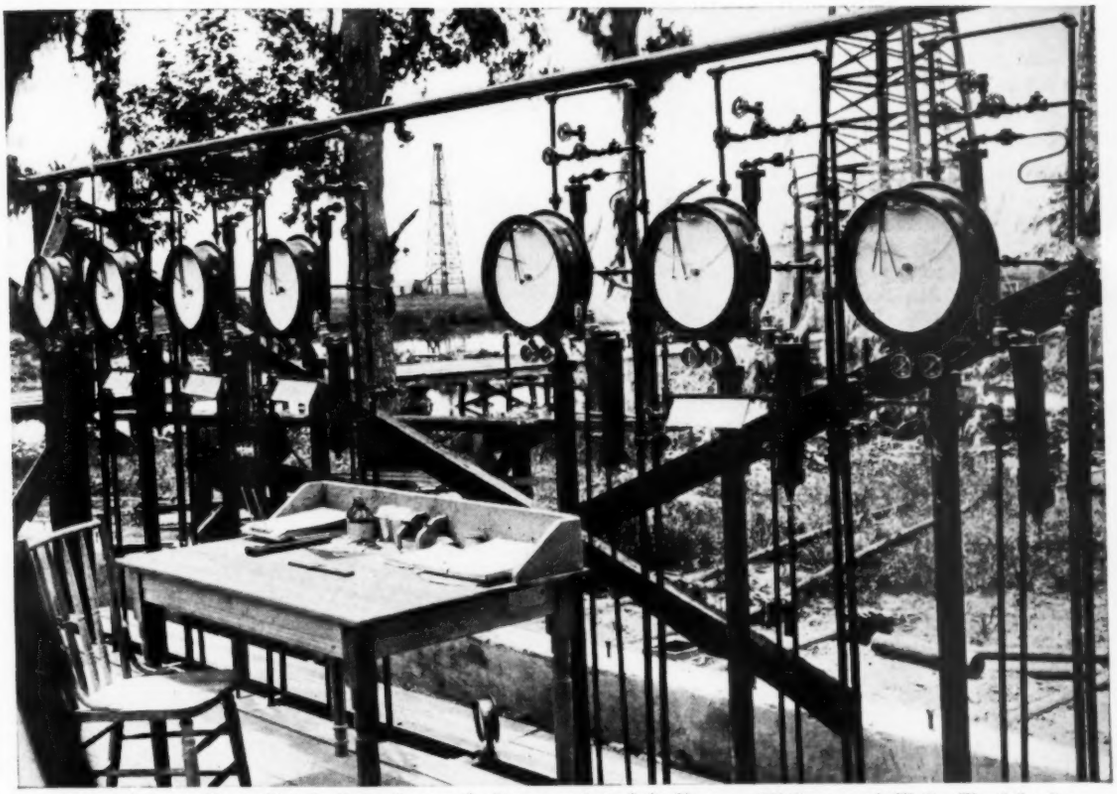

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The diagrams shown will represent the best condition that could exist with the measurements as they are. For example, it will be noted in Diagram No. 1 there exists a difference of .028 inch between the measurement taken at top and that taken 5 inches down. To make the diagram, differences in wear have been halved and an equal amount shown at either side of the center line of cylinder. However, it is definitely known that this is oftener than not the reverse from what is actually found. It can be readily understood that the liner is very likely to wear more on one side than on the other. For example, it might be considerably more from the center line of liner to a point at 0 degrees, than it is from the center line to the opposite point at 180 degrees. This being the case the results would be worse than the condition as depicted in the diagrams. However, for a brief study of the question, it is assumed that the best condition exists, i. e., that the wear as measured from the center line of the liner at any given height would be equal on either side as shown at 3 inches down in Diagram No. 1 where the total wear is .060 inch, equally distributed to give .030 inch at either side.

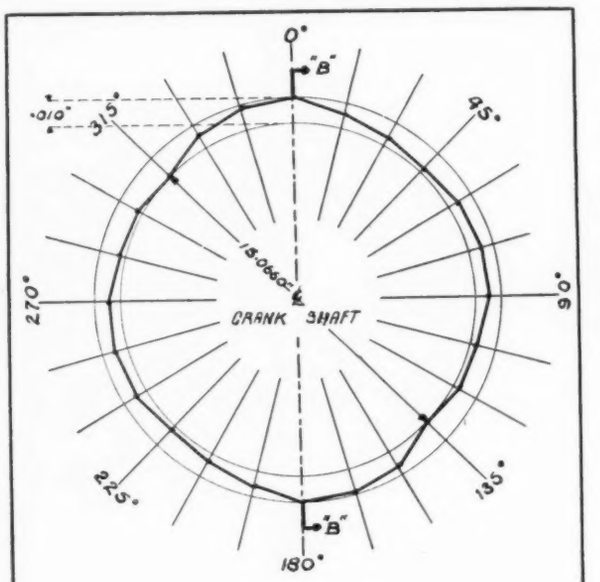
Even allowing the condition to be as stated above, the fact still remains that there exist considerable irregularites in the liner, and it is difficult to imagine how rings last as long as they do or how engines continue to function as economically as they do under such circumstances.

Theoretically, the ring is supposed to seat on the liner all the way round, and be assisted in this by the gas pressure acting behind it. However, it seems impossible to expect any ring to conform automatically to such a variety of conditions as are met. Not only would it have to fit each irregularity around its circumference, but also accommodate itself to the variations at each point in its travel upward and downward.

If the wear were made up of a series of regular grooves running lengthwise of the liner, the ring might gradually wear in after a certain time, but a study of Table No. 1 will show that there is no regularity in this respect. Although it is generally accepted that gases behind the rings assist in making a seal, it seems very doubtful if this can be the case in many instances. In fact, it would appear that the reverse might be true very often, more so when carbon has formed behind the ring and acts as a seal against the passage of the gases.

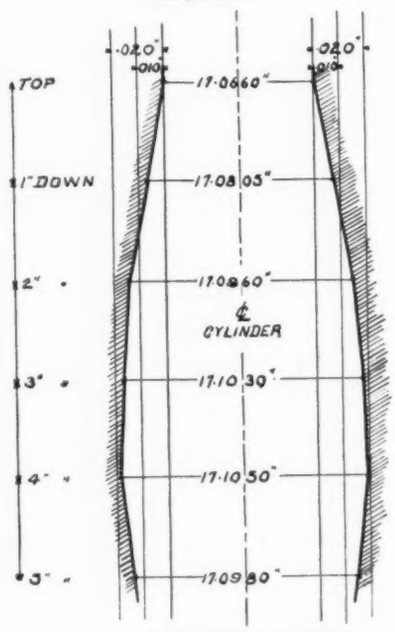
It has been stated by several that the attempt to measure liners to close limits is useless; however, it is as easy to make correct checks as it is to do the work in a haphazard manner, and it is felt that if the subject were given serious consideration by companies operating a large number of Diesel engines the engine builders would readily co-operate. The pipe lines are a wonderful proving ground for the manufacturers and they seem to be eager to do what they can to make improvements when such are possible.

To cite an example, Diagram No. 3 represents an engine which has given satisfactory service, but the liners do not last as long as many others do. A great deal of work has been done to try to find out just what the cause or causes may be, and every time a theory has been advanced to the builders it has been given every consideration. By such co-operation not only will the pipe line industry be benefited, but the Diesel engine industry as a whole will be able to manufacture a better product.



CROSS SECTION
AT "A"—"A" ON DIAGRAM 1

Diagram 2.



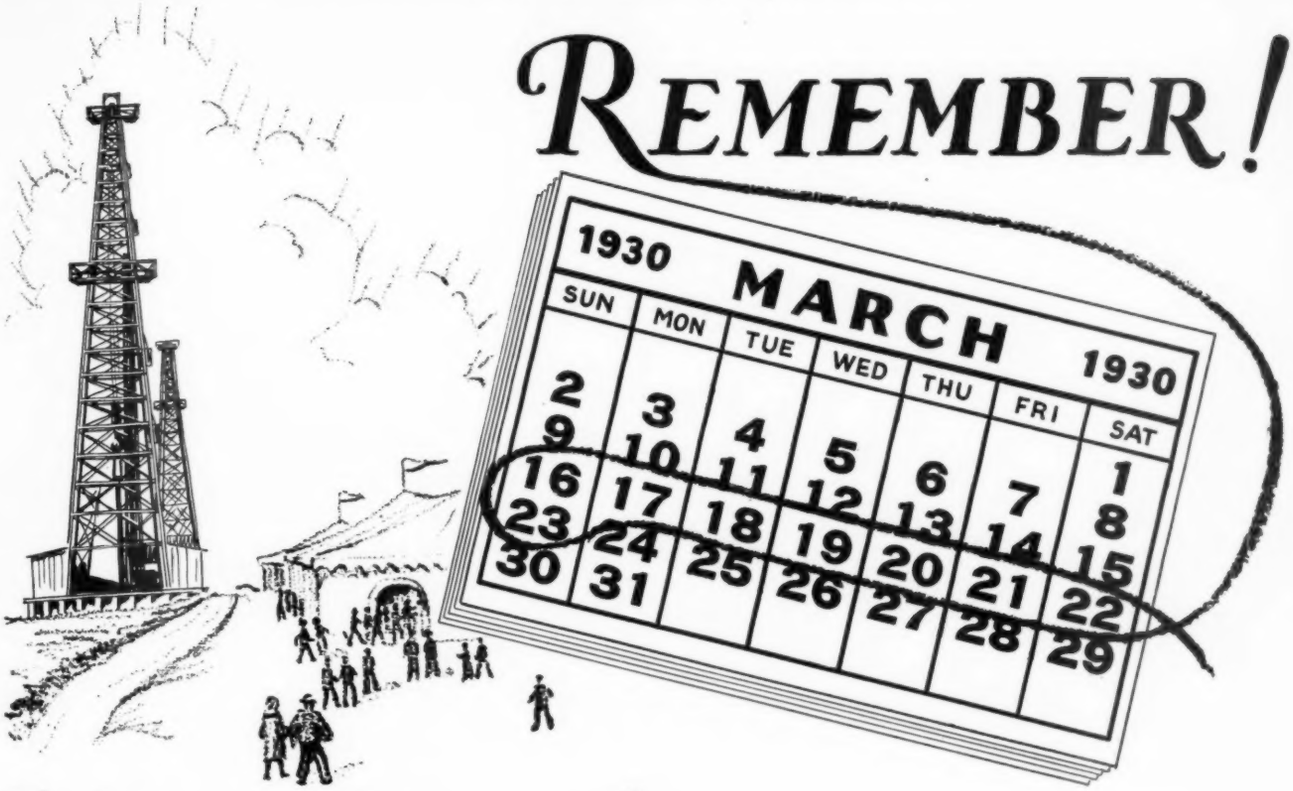
VERTICAL SECTION
TWO CYCLE ENGINE

Diagram 3.

At least two pipe line companies have been keeping records of liner wear for several years, and their efforts have been rewarded in more than one instance by finding the cause of rapid wear and remedying same by making some alteration to the unit itself or by adding such auxiliaries as air filters, centrifugal machines for fuel oil, etc.

It is not suggested that measurements be taken every 15 degrees around the liner nor is it deemed necessary to take the measurements any great distance down the liner unless the unit is found to show greater wear lower down than at the top. Experience with a particular engine or type of engine will soon show how far it is necessary to go. It is believed that taking checks at four points around the liner, as shown in Table No. 1, is all that is required.

The study of liner wear is extremely interesting and educative, and if care be exercised in making the checks much valuable information can be obtained. With a large number of engines checked about once a year, the results logged and tabulated, a surprising difference will almost certainly be found to exist. To make a good comparison, the total number of hours the engine has run should be divided by the wear in thousandths of an inch; the resulting figure will be the average number of hours the unit has run for every .001 inch wear. For example, if an engine has run 42,000 hours, and the point of greatest wear is found to be .070 inch, the average would be 600 hours per .001 inch wear. In this connection it is suggested that the station log be kept up to date every day by adding on the hours run.



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Economies Resulting from

Proper Handling *of* "Cut" Oil

By C. D. MILLER[1] *and* R. W. SPENCER[1]

DUE to existing prices of crude oil, it has become necessary for the producer to practice the most stringent economy in all phases of his operations. The problem of cut oil is one phase that increases with the oncoming of winter, and during the cold months the cost of treating assumes no small part of the lifting costs. In an effort to reduce this cost a systematic survey of each property was made, and corrective methods adopted wherever necessary.

In many instances it was found that by proper regulation of the stroke and pumping hours of wells, treating could be eliminated entirely. On one lease where it had

[1] Production Department, Barnsdall Oil Company.

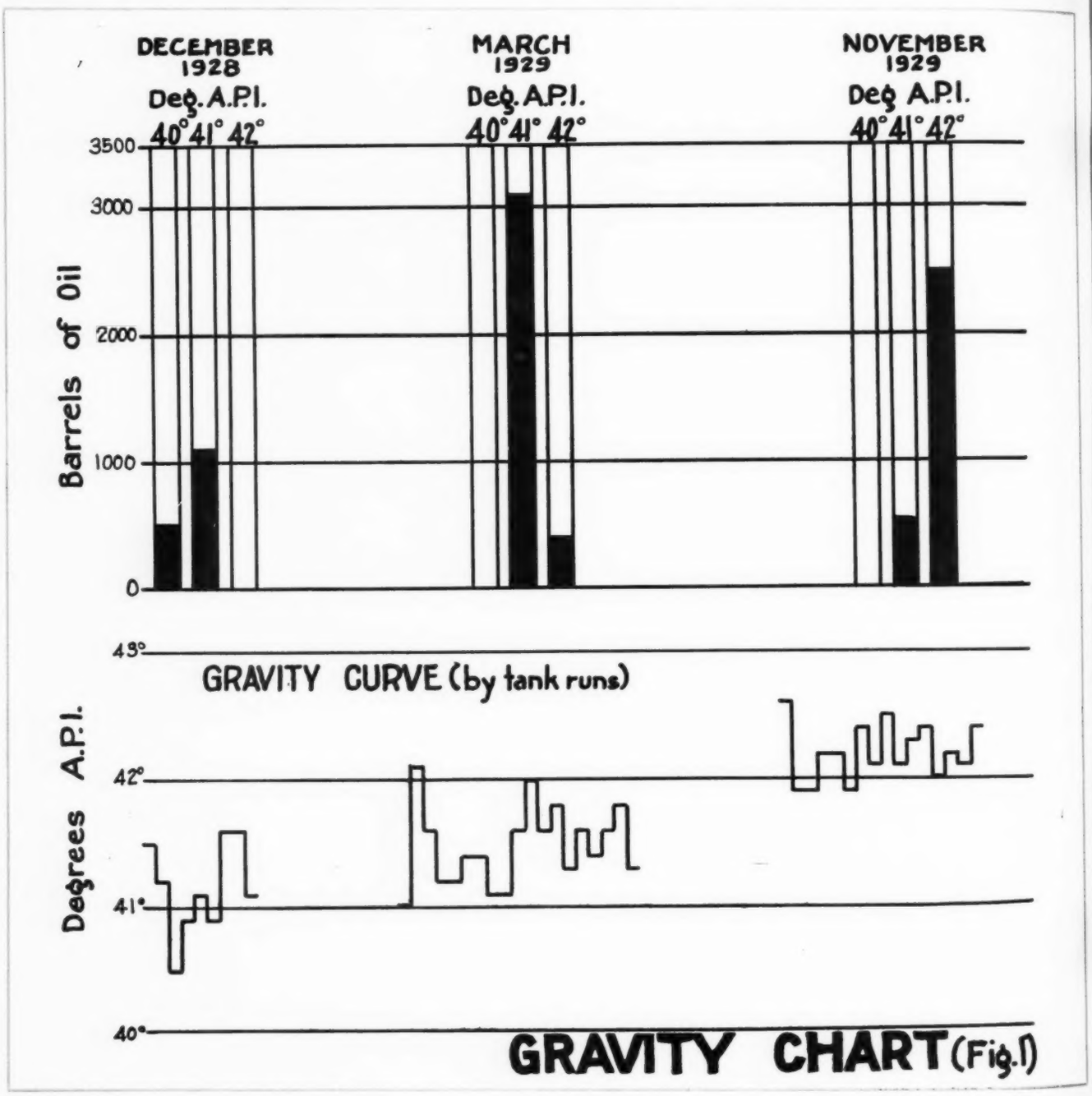

FIG. 1
Chart shows how the gravity of the oil was raised from 39 to 42 degrees A. P. I. and the emulsion lowered from 2 per cent to ½ per cent by improvements in lease equipment arrangements for handling the oil as it comes from the well.

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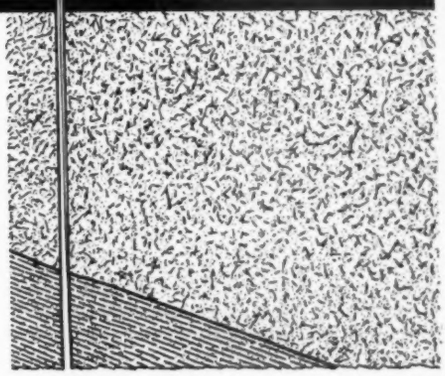

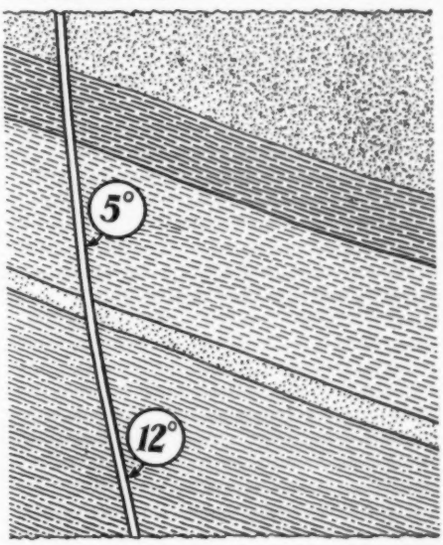

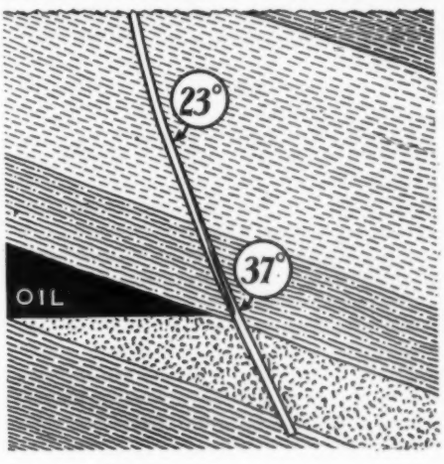

The illustration above shows the complete hook-up of the Driftmeter at a drilling well. The special winch mounted on suitable truck chassis controls the electrical cable in the well from which is suspended the instrument. When the Driftmeter has reached the depth at which a reading is to be taken, the winch is stopped, the operator at the truck presses the button which establishes electrical connection between the actuating mechanism in the hole and the recording dial. At the moment of contact the needle on the dial instantly indicates the inclination of the shell in the hole. When the reading has been taken, the moisture proof case containing the actuating mechanism is raised or lowered to the point where the next reading is to be made. Readings taken while running in may be checked by a separate set on the return trip.

An idea of the speed with which readings can be taken with the Driftmeter is indicated by the fact that 17 readings were made in one well in 25 minutes (exclusive of 15 minutes pulling out time) in 6⅝ casing full of oil. Similar speedy records have been established in both rotary and cable wells. Accuracy of the readings taken with the Driftmeter has been checked with the acid bottle, and in every case the same general trend of deviation has been recorded.

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been necessary to use both heat and chemical, the wells were tested at various intervals while pumping, and a great variation in both gravity and per cent emulsion was noticed. It was also discovered in most cases that the gravity at the tanks was lower and the per cent emulsion higher than at the wells. On this lease the pumping time was reduced, all right angles and bends in lines eliminated, tanks fitted with baffled conductor pipes, and the gravity was raised from 39 degrees to 42 degrees A. P. I., while the per cent emulsion was lowered from 2 per cent to ½ per cent.

The accompanying chart, Fig. 1, is of a lease illustrating this point. In December, 1928, 40% of the oil was 40 degrees and 60% was 41 degrees. In March, 1929, 84% of the oil was 41 degrees and 16% was 42 degrees. In November, 1929, 22% of the oil was 41 degrees and 78% was 42 degrees.

Because of the various factors entering into the problem, no effort was made to standardize on a treating plant. In general, though, it was discovered in any treating project there is a certain combination of heat and chemical by which it is possible to obtain the best results. In many cases, by adding more chemical it was possible to reduce the temperature, thus materially reducing evaporation losses and steam requirements. To be specific, on one lease producing approximately 6000 barrels a month, by cutting down the temperature and using more chemical the following increase in revenue was realized:

Gravity increase, 1 degree	$300.00
Evaporation losses—decreased	148.00
Steam requirements—decreased	99.00
Total increased revenue	$547.00
Increased cost of chemicals	15.00
Total profit	$532.00

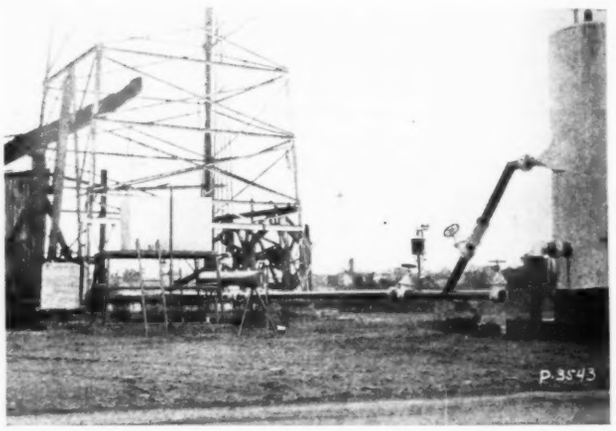
Like results were realized on many other leases. On some it was found that good results could be obtained only by treating. In all such cases a careful study was made and the best combination of heat and chemicals used. Owing to the different characteristics of crude oil, it was found next to impossible to standardize on any one form of treatment or chemical. It was necessary to determine first the chemical applicable to the type, and then the best process of heating. To obtain best results, chemicals were introduced at a point of the greatest agitation.

On a lease showing cut oil from one or two wells, lubricators were placed near the well, which usually handled the cut oil satisfactorily. If several wells were cutting, they were run into a header, with a chemical lubricator attached, through a series of baffles into the receiving tank. This method was used where heat was not available and the quantity of emulsion not too great. By diluting the chemicals better lubrication was obtained. Where a separator was used, the chemicals were introduced before the oil reached the separator. On gas lift wells, the chemicals were lubricated into the gas input lines.

Several types of heaters were used in treating oil. In small production a 6⅝-inch casing over a furnace was used to advantage. Another type was made from 15- or 20-inch casing, with boiler flues welded in. For heavy production the flues were cut out of an old boiler, the shell set upright and the dome used for a fire box.

The accompanying sketch, Fig. 2, shows a typical heating plant installation. One idea in this system that has reduced materially the cost is the cold water bath, to which the oil is subjected just after leaving the second settling tank. This reduces the temperature of the oil, together with a corresponding reduction of the steam required. The closed system of heating is always used and a thermostat controls the temperature.

It is believed in a great many cases of old settled production that the proper method of pumping, together with the elimination of right angles and bends in the lines, and the proper preparation of tanks, much of the cost of oil treating may be avoided.



A hook-up for treating cut oil on a lease in the Greater Seminole area.

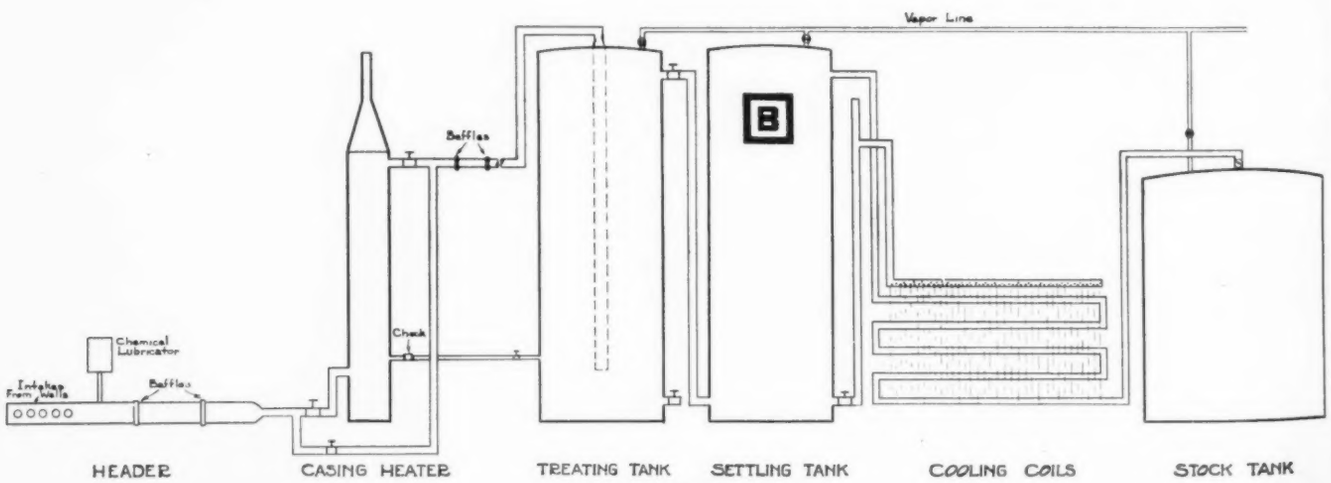
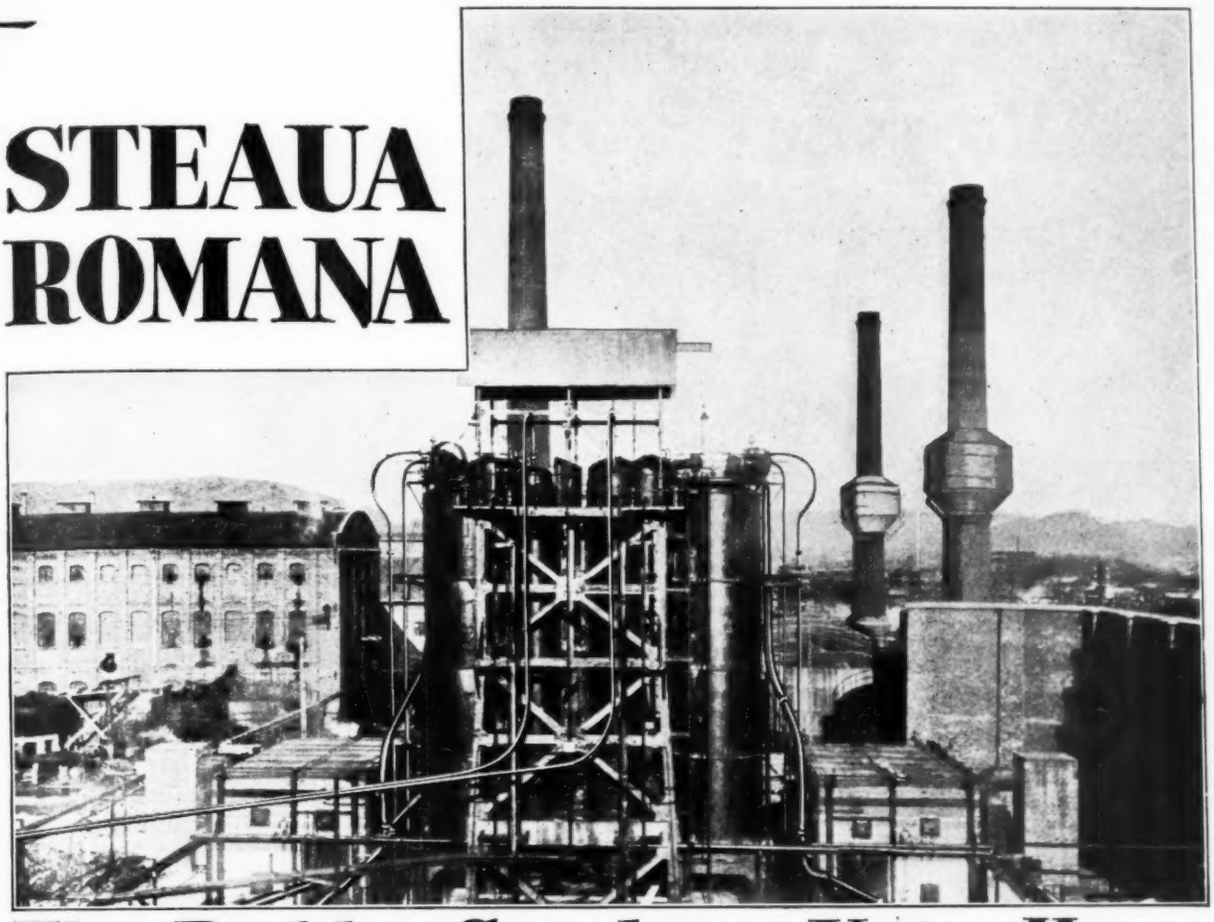


FIG. 2

Typical heating plant installation for treating cut oil used by the Barnsdall Oil Company in the Mid-Continent. Note the cooling coils for reducing the temperature of the oil before it is run to the stock tank.

at STEAUA ROMANA



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Yates Pool Committee

Proposes Proration Method

Based on Rock Pressure

UNUSUAL interest attaches to this paper because it represents one of the first attempts to get away from the arbitrary open-flow methods for determining the potential production of a flowing oil well, and put into practice a method which depends on the rock pressure for the adjusting factor. It should be stated that conditions in the Yates Pool are particularly favorable for the application of the proposed method.

According to the findings of the committee which proposes and recommends the method after some experimentation in the field, the method is accurate and equitable. The same general method can be used to determine the absolute open flow of a well from its flow under high back pressures. It is concluded that open-flow testing is harmful to the long life and economical operation of the Yates Pool.

The paper is part of a report recently submitted to the Advisory Committee of the Yates Pool by the Yates Pool Engineering Committee composed of G. L. Klingaman, California Company; T. W. Rhoads, Gulf Production Company; Clyde Temple, Humble Oil and Refining Company; W. A. Schaeffer, Shell Petroleum Corporation; P. S. Haury, Simms Petroleum Company, and (chairman) W. V. Vietti, The Texas Company. No action has yet been taken by the committee on the report. It is now under consideration and will come up for hearing at a later date.

The open flow testing of wells in the Yates Pool has been studied and found wanting. Another method to determine potential production has been sought. A method has been worked out by the Engineering Committee and is presented.

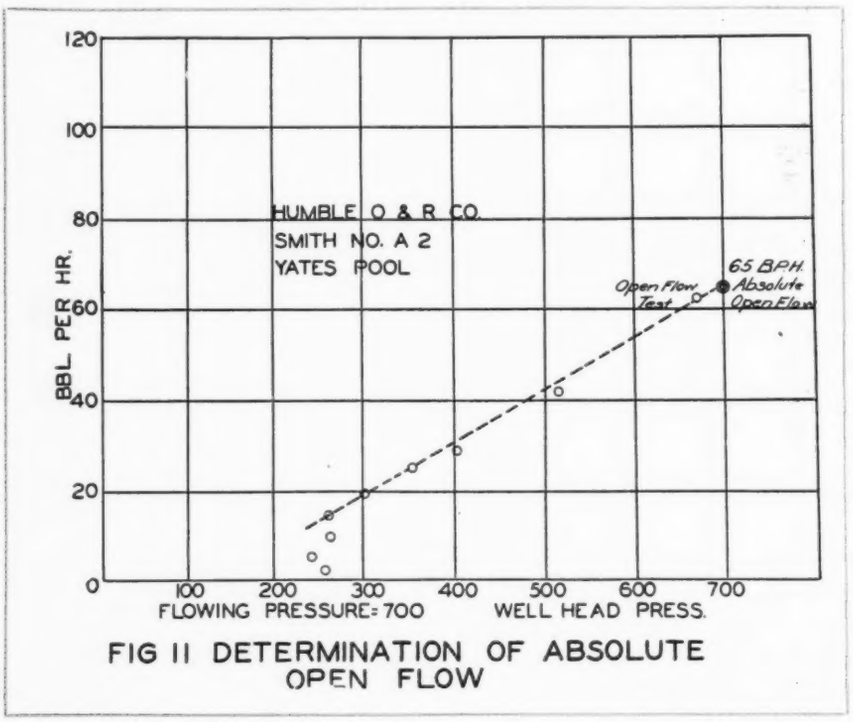


FIG 11 DETERMINATION OF ABSOLUTE OPEN FLOW

Production characteristics of typical Yates Pool wells were determined by experimentation. Some of these results have been presented in previous paragraphs. The factors which limit a well's open-flow capacity are essentially: (1) the rock pressure; (2) nature of the fluid; (3) friction to flow through the formation and up the casing to the surface. In addition the back or well-head pressure must be overcome.

Rock Pressure

Rock pressure is used throughout this discussion to mean the pressure in the formation as determined by the pressure in gas wells or by bottom-hole pressures taken while the well is shut in.

California Smith 3-35-3 was completed November 8, 1929, and produced 218,616 barrels of oil to November 14, 1929. This well is allowed to flow con-

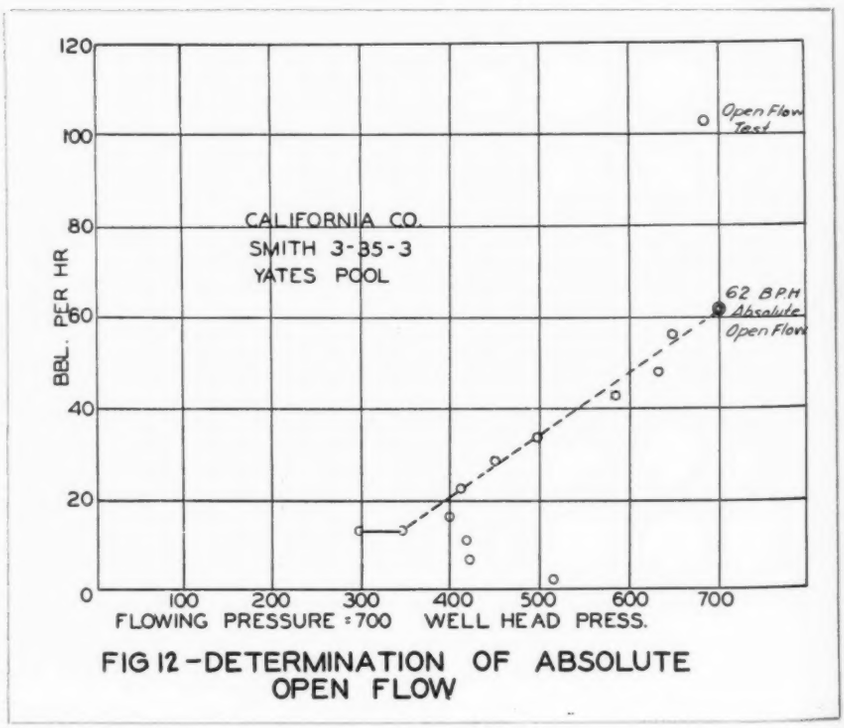
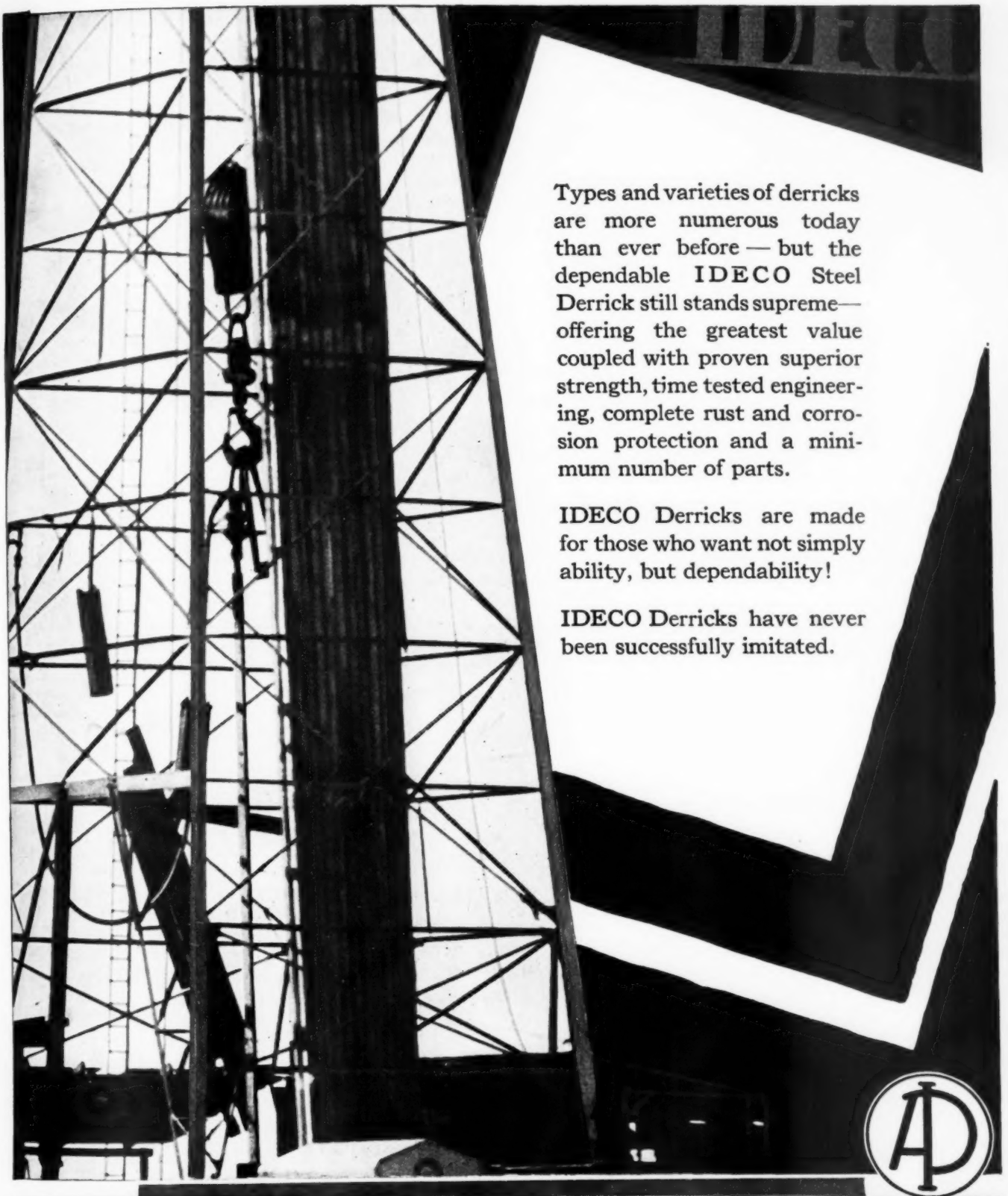


FIG 12 – DETERMINATION OF ABSOLUTE OPEN FLOW



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tinuously through a small bean. A bottom-hole pressure was taken on this well November 14, 1929.

Pressure Determination:

Well shut in		11:15 A. M.
Pressure bomb run in 3:26 P. M.	Well head, 370	lbs.
Pressure bomb started out 3:35 P. M.	Well head, 375	lbs.
Pressure bomb out 3:46 P. M.	Well head, 380	lbs.
Pressure found in bomb		677.4 lbs.

Shell Tippett Nos. 9 and 11, show a shut-in pressure of 700 lbs. These wells make considerable gas and this may be taken as the formation pressure in this area.

Rock pressures taken in 1927 indicated a pressure probably in excess of 700 lbs.

The rock pressure in the Yates Pool is therefore assumed to be 700 lbs. per sq. in. in the larger portion of the pool.

Production Versus Rock Pressure

Production rates were plotted against the effective flowing pressure in Figs. 11, 12, 13, and 14. The flowing pressure was determined by subtracting the well-head pressure from 700.

Results obtained on Humble Smith A-2 are plotted in Fig. 11. The proration test of 62.39 bbls. per hour was obtained at 30 lbs. back pressure. The open flow, had the well-head pressure been zero, would have been 65 bbls. per hour.

Results obtained on California Smith 3-35-3 are plotted in Fig. 12. The proration test of 103 bbls. per hour was obtained at 18 lbs. back pressure. This well is similar in all characteristics to Humble Smith A-2. The difference in proration tests is caused by the fact that the California well is finished with 8¼-inch casing, and the Humble well with 6⅝-inch casing. Smith 3-35-3 was shut in before the proration test and made a large head. The true open flow for Smith 3-35-3 is 62 bbls. per hour.

The results on California Smith 3-35-12 are presented in Fig. 13. The proration test of 162 bbls. per hour was obtained at 0 lbs. back pressure.

The results on Shell Tippett 11—see Fig. 14—show an absolute open-flow test of 260-263 bbls. per hour as compared to the 245 bbls. per hour obtained at 40 lbs. back pressure. This well shows that a line drawn from Zero (0) pressure through the proration test value would approach the true open flow. In this case the difference would be 3 bbls. per hour.

Gas affects these curves by lightening the fluid column in the casing and allowing more of the pressure to be effective in causing flow. Humble Smith A-2 has a gas-oil ratio of 800-900 cu. ft. California Smith 3-35-3 has a gas-oil ratio of 300-500 cu. ft. The difference is shown by the decrease in Smith A-2 flowing pressure necessary to start flow.

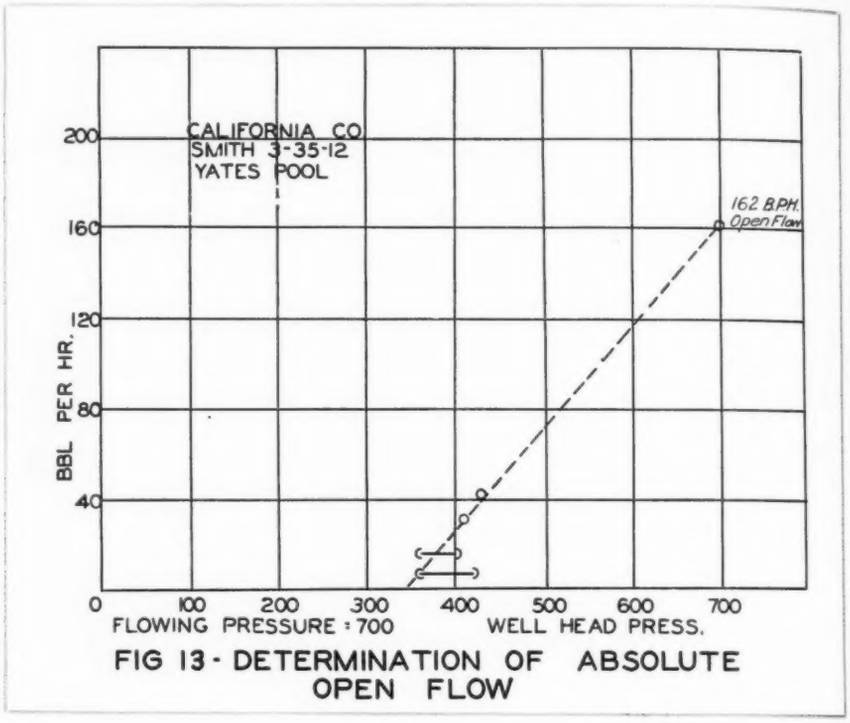


FIG 13 - DETERMINATION OF ABSOLUTE OPEN FLOW

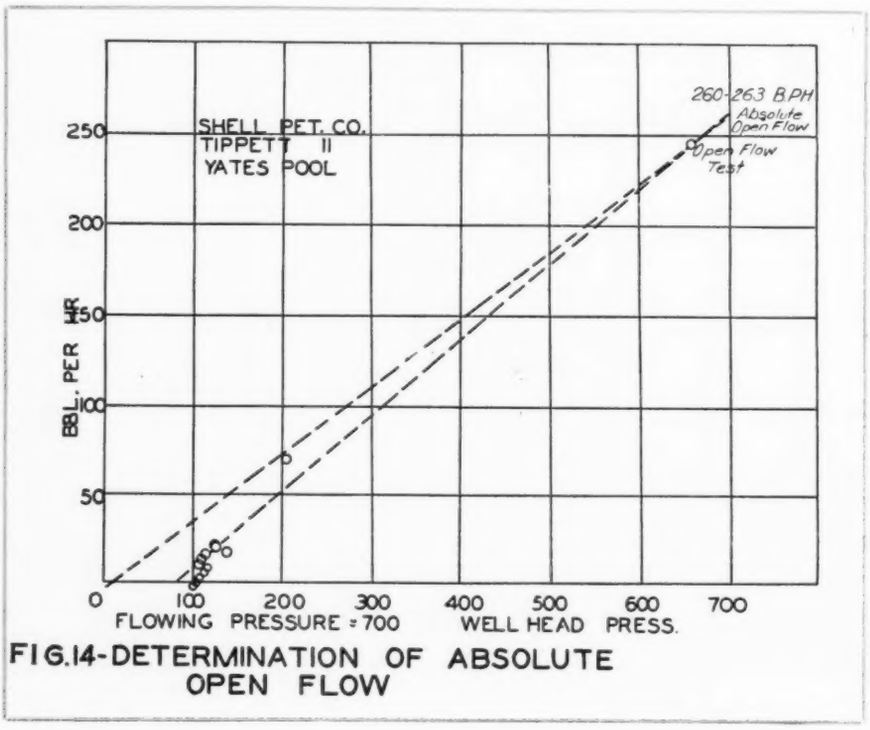


FIG.14-DETERMINATION OF ABSOLUTE OPEN FLOW

Water will increase the pressure necessary to start flow, in opposition to the effect of gas. Water encroachment is preceded by a decrease in gas-oil ratio and a decrease in well-head pressure. This is due partly to the decrease in gas. Flow to the well bore is caused by higher pressures back in the formation. As soon as a water column moving towards a well comes into the proximity of the well bore we have the following items to cause a decrease in well-head pressures: the decrease of gas in the stream of fluid moving towards the well bore, the decrease of oil, and the increase of water increase the density of the fluid stream and increase the pressure used up in starting flow.

Laboratory Direction Is

Operating Modern Gasoline Plant

THE operation of the natural gasoline plant in the Magnolia Gas Company's station at Latex, Texas, is controlled by the plant chemist in connection with a well-equipped chemical and physical testing laboratory located at the plant. The natural gasoline plant is a Braun absorption type. The absorbers are designed to operate under 500 pounds per square inch working pressure. There are seven absorber towers, each having a capacity of 5,000,000 cubic feet of gas per day, or a total capacity of 35,000,000 cubic feet.

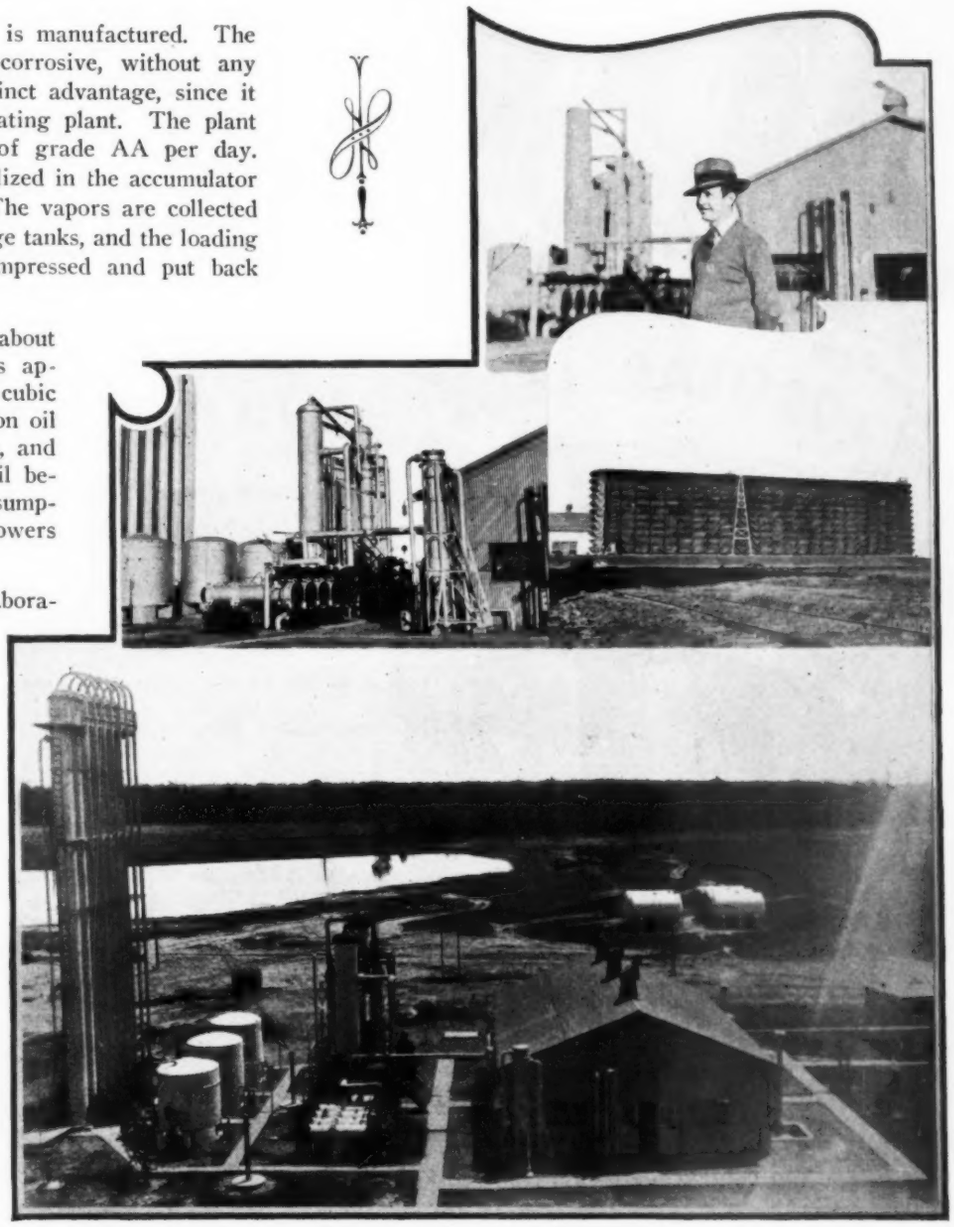
The plant is equipped with automatic control instruments, including liquid level, temperature, and pressure controls. These instruments minimize the labor required for operation, and maintain the yields and quality on the finished product.

Only grade AA natural gasoline is manufactured. The product is doctor sweet and non-corrosive, without any chemical treatment. This is a distinct advantage, since it eliminates the installation of a treating plant. The plant manufactures about 5,000 gallons of grade AA per day. The distillate from the unit is stabilized in the accumulator tanks by means of a steam coil. The vapors are collected from these tanks and from the storage tanks, and the loading rack, while loading cars are recompressed and put back into the absorbers.

The gas enters the absorbers at about 450 pounds pressure, and contains approximately 0.2 gallons per 1,000 cubic feet. A 36-degree gravity absorption oil is used. A distillation, unsaturates, and an emulsion test are run on the oil before using. The absorption oil consumption is very low except when the towers are overloaded.

The convenient location of the laboratory enables the chemist, R. D. Hanley, to keep in close touch with the operation, and makes sufficient tests to maintain the most economical operation.

One of the features of the plant is the color scheme of painting various oil and gas lines. This enables the operator to tell at a glance what the line or unit contains.



Top—Specially constructed device for loading gasoline in tank cars. Directly below—R. D. Hanley, Plant Chemist, Magnolia Latex Plant. Center, left—Braun distilling unit, Magnolia Latex Plant. Center, right — Cooling tower, Magnolia Latex Plant. Lower—Magnolia gasoline plant, Latex, Texas.

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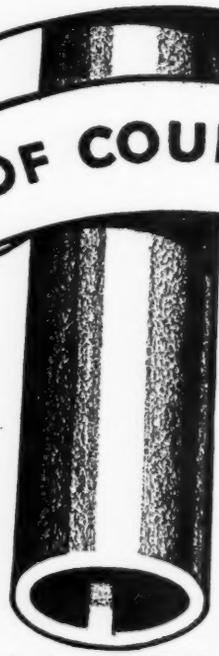

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A Simplified Method for Routine Computations of

Gas Volumes and Gas-Oil Ratios

By KENNETH S. RITCHIE

FOR computing gas volumes and gas-oil ratios from a number of orifice meter charts the time required can be shortened considerably by using the simplified system described below.

This system, without impairing the engineering accuracy of the results, saves time by reducing the number of steps required in the usual procedure for computing gas volumes.

The following equipment is necessary:

1. A radial planimeter is used to obtain the average static and differential pressures from the curves recorded on the orifice meter chart.

2. Direct-Reading Conversion Scales (Fig. 1) for each kind of meter chart used are constructed for the particular planimeter at hand. These scales take care of this planimeter's instrument constant.

3. A Kardex Desk File, which holds sixty 4 by 6 cards (Fig. 2), is used to keep the orifice data and coefficients for each meter readily accessible.

4. The Gas-Volume Computation Chart (Fig. 3), is used to solve the regular orifice meter formula:

$$Q = k\sqrt{h \times P}$$

where: Q = Volume of gas in M. cu. ft. per hr.
k = Corrected hourly coefficient, based on inside diameter of pipe, size of opening in orifice plate, temperature and specific gravity of gas, and type of meter connections.
h = Differential pressure drop through the orifice, in inches of water.
P = Static pressure in the line, in pounds per square inch absolute.

5. A 20-inch Keuffel & Esser Polyphase Duplex Slide Rule is used for converting the volume of gas in one hour (taken from the computation chart) to twenty-four hours and for computing the gas-oil ratio.

6. Production Data Sheets, similar to the one shown in Figure 4, are recommended for keeping the computed gas volumes from each well together with other pertinent production data from that well. To save time, the computed gas-volumes can be recorded directly on these sheets.

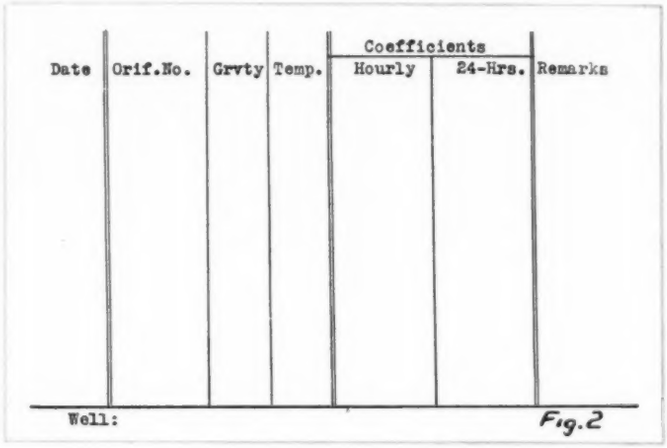

Fig. 2

Construction of Planimeter Conversion Scales

It is recognized that the radial planimeter does not give the utmost accuracy in taking off average pressures from orifice meter charts. For the purposes of the petroleum engineer, gas-volume data do not need to be as accurate as that used in metering gas for sale. He is more interested in checking the results of recommendations made for operating wells, both by natural flow and by gas or air lift. The accuracy of the radial planimeter is well within the accuracy of the other data obtained from the wells and used by the engineer in his computations.

The simplest way to obtain the value of the average static pressure, or the average differential pressure, from the planimeter reading on a chart is to take the corresponding pressure scale value from a direct-reading conversion scale constructed for the particular planimeter being used on that chart. Figure 1 shows a set of these scales made for Foxboro planimeter No. 619, for use on certain kinds of Foxboro, Metric, Bristol, and Tycos charts.

Each scale was constructed as follows: Using an M100 Metric chart for illustration, (1) Check planimeter readings were taken at ten-unit intervals from the zero circle to the 100 circle on a new, unused chart; (2) These values were used for plotting a curve on regular K. & E. engineering cross-section paper with 20 lines to the inch. An ordinate scale, approximately 20 inches long, was used for the planimeter readings and an abscissa scale of suitable length was used for the meter chart scale values. (3) The direct-reading conversion scale was drafted in pencil by laying off the planimeter scale with uniform division marks on the underside of a horizontal line, approximately 20 inches long, and then marking off lines on the upper side for the corresponding unit chart pressure values read from the previously drawn curve. Intermediate lines for tenths of units were drawn in next and the two scales appropriately numbered before inking in the lines. In this example, the M100 scale was made useful for the M050 and the M1000 charts by the addition of more numbers of appropriate value. It is possible in this way to use one scale for several kinds of charts when the chart scales are multiples of the first chart scale drafted.

A complete set of direct-reading conversion scales for the various kinds of charts handled can be drafted on the same sheet. A photostatic copy of the finished set of scales can be mounted on a board fastened to two triangular supports which raises the photostat to a convenient angle from the desk top. This mounted copy of the conversion scales can be set in front of the computer and used directly as each chart is planimetered. The resultant pressure values can be recorded directly on the chart. This arrangement does away with several motions necessary in the routine use of planimeter tables, or a computing machine. After the chart has been planimetered, it is ready for the gas-volume computation.

Visible Card File For Orifice Coefficient Records

The experience gained by handling numerous charts from many meter installations proved the value of keeping a record of all changes in orifice data for each meter in order to keep the orifice coefficients straight. A convenient method of keeping this record is on 4 x 6 cards, ruled as shown

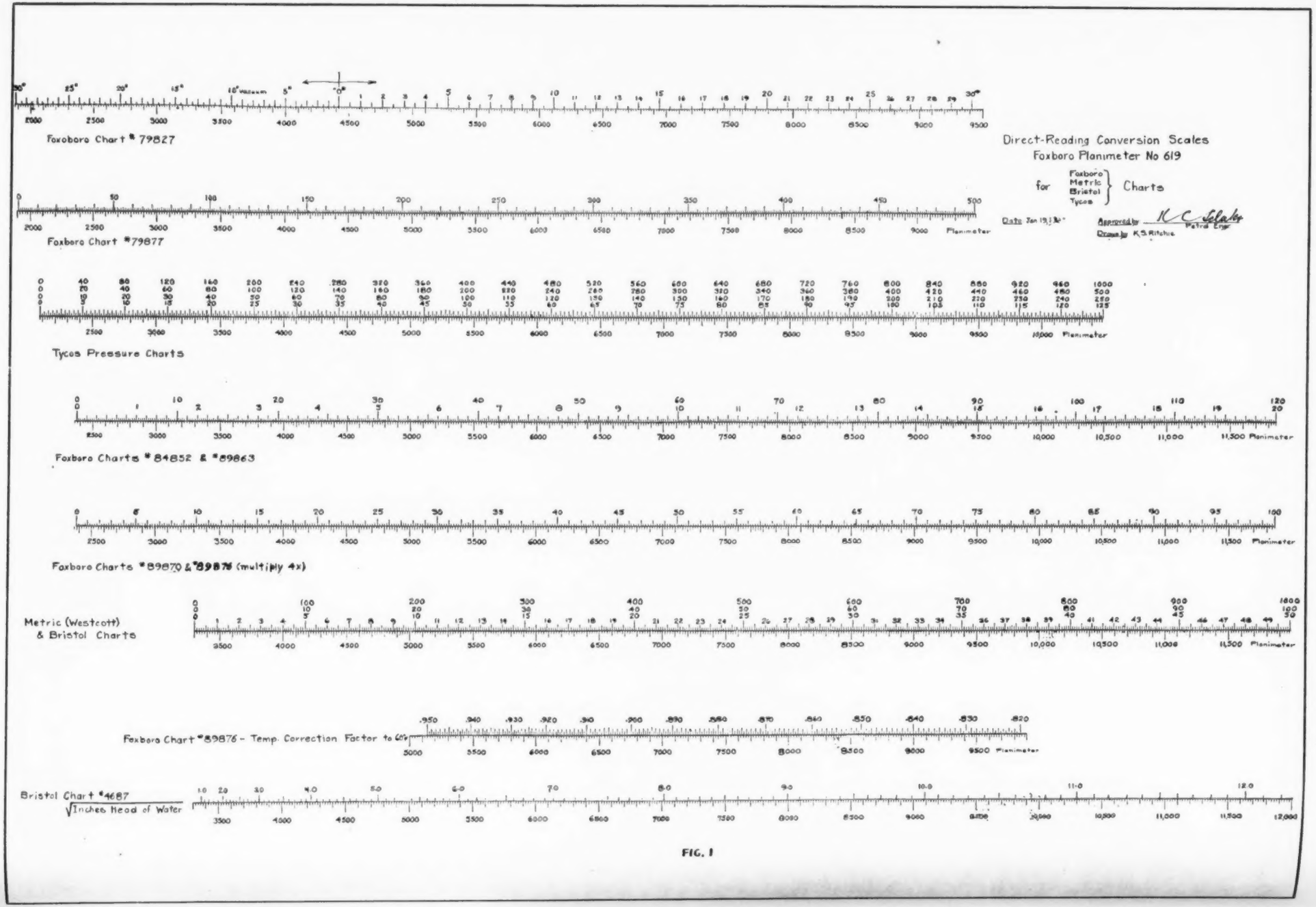
Foxboro Chart # 79827
Direct-Reading Conversion Scales
Foxboro Planimeter No 619
for Foxboro Metric Bristol Tycos Charts
Foxboro Chart #79877
Tycos Pressure Charts
Foxboro Charts #84852 & #89863
Foxboro Charts #89870 & #89876 (multiply 4x)
Metric (Westcott) & Bristol Charts
Foxboro Chart #89876 - Temp. Correction Factor to 60°
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FIG. 1

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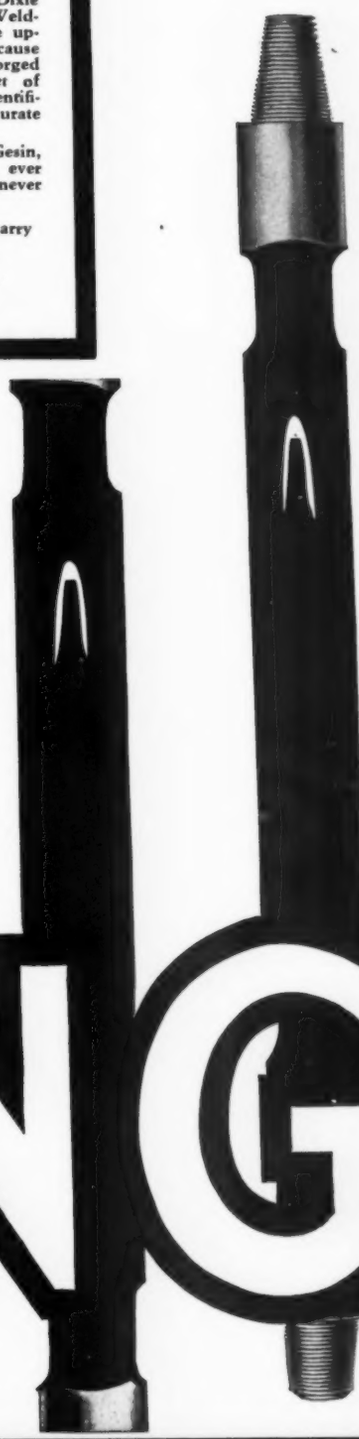


SPANG

WELDLESS JARS

in Figure 2, and kept in a Kardex Desk File. In this arrangement, the data on the cards are very accessible for recording any changes in the data and for finding the corrected coefficients for each volume computation.

Gas-Volume Computation Chart Eliminates Extension Tables

The gas-volume computation chart (Figure 3), desk size, is approximately 16 to 18 inches long, takes the place of extension tables and a calculating machine in solving for the volume of gas by the regular orifice meter formula: $Q = k\sqrt{h \times P}$. The formula is solved in two steps on this chart. First, from the orifice meter chart previously planimetered, one takes the average differential pressure (h) in inches of water, *not* the square root value, and locates this number on the scale at the extreme right. Then, the average static pressure (P) reduced to absolute pounds per square inch, *not* the square root value, is located on the third scale from the right. A ruler, or a straight-edge, is laid across these two points (see dotted line [1] in Figure 3) and the intersection with the blank reference line is noted. The value of the corrected hourly orifice coefficient (k) for this meter chart is taken from the card in the Kardex file and is then located on the scale at the extreme left of the computation chart. The straight-edge is used to connect this point with the one on the blank reference line (see dotted line [2] in Figure 3). The volume of gas (Q) in M cubic feet per hour is the value at the point of intersection of the straight-edge and the second scale from the left. The corresponding volume of gas for one day is quickly obtained by using the slide rule for multiplying the volume of gas for one hour by twenty-four.

A concrete example of computing gas-volume by this method is given here and solved by way of illustration.

These values are given: h = 6.4 inches static.
P = 86.4 pounds absolute.
k = 0.74.

"Q", the volume for one hour, is found:

(1) Connect "h" and "P" with line;

(2) Connect "k" and point of intersection on blank reference line;

(3) Read "Q" = 17.4 M. cu. ft. per hr.

It will be noted that the resultant volumes for twenty-four hours can be computed in many instances to the nearest unit M cubic feet. A little practice in using the gas-volume computation chart will help one to read the different scales more readily and accurately. Speed will come with use.

With the equipment outlined prepared, it will be found that computation work divides itself into three main steps:

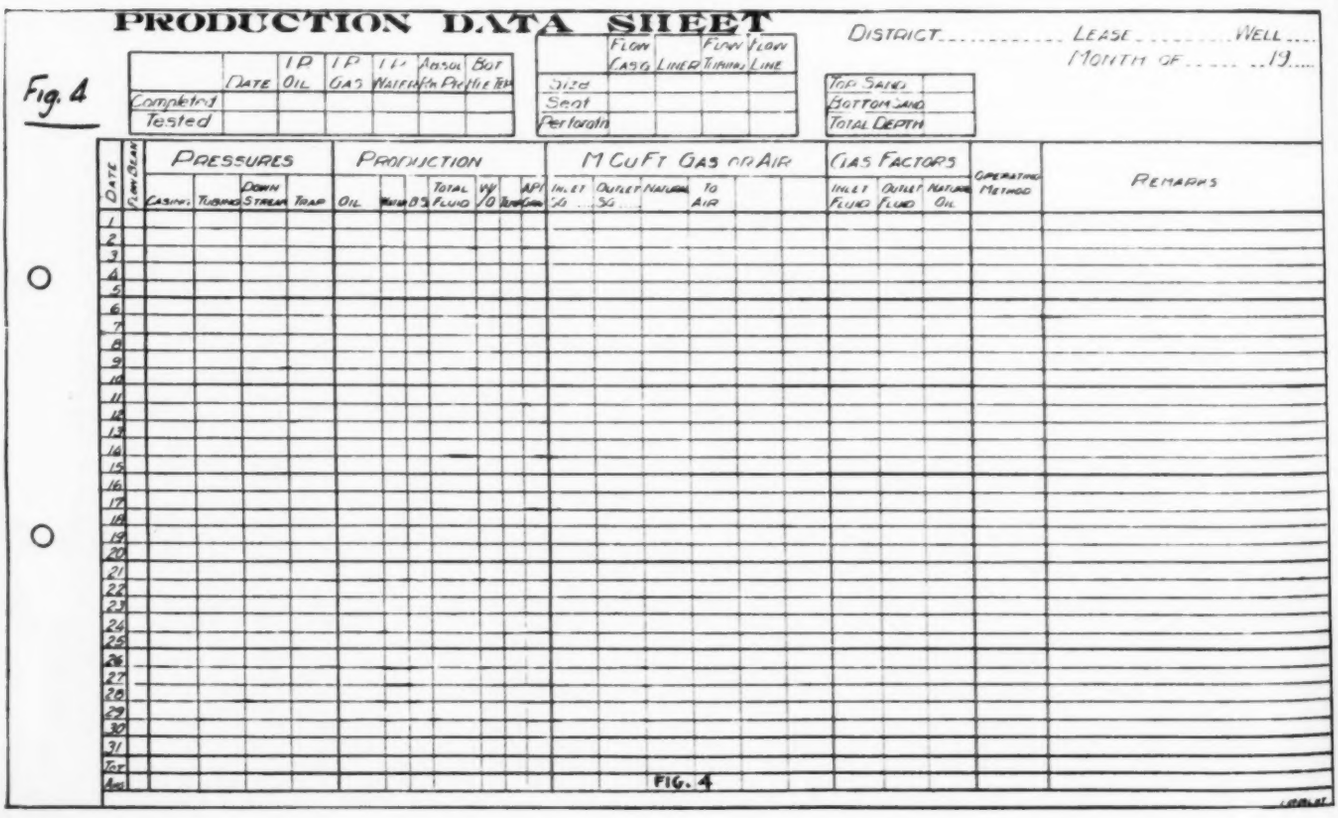
First. A pile of orifice meter charts can be planimetered and the average pressure value recorded immediately after the planimeter has passed over each curve.

Second. Then the computation chart can be used to obtain the gas-volumes for all of the charts in the pile.

Third. Where gas-oil ratios are desired, the gas-volumes can be copied on the Production Data Sheet (similar to one shown in Figure 4) and the slide rule used for computing the gas-oil ratio.

Other time-saving ideas will suggest themselves to those engaged in the computation work on many orifice meter charts. The system described here was in active use for over a year in handling a large number of meter charts daily, and effected a considerable saving in time.

Fig. 4



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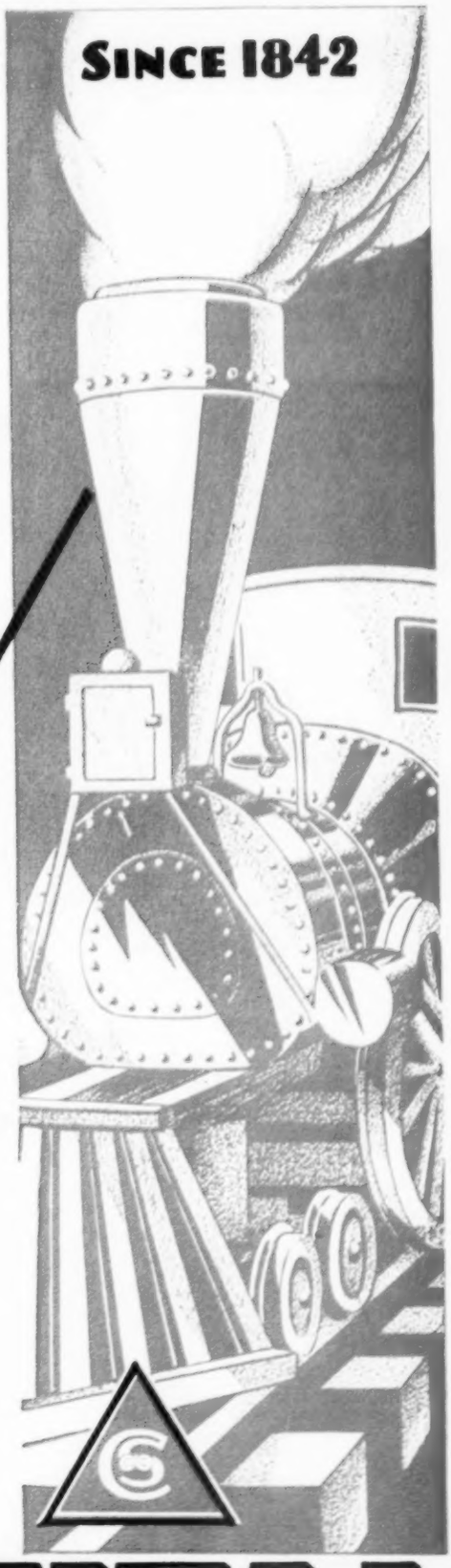

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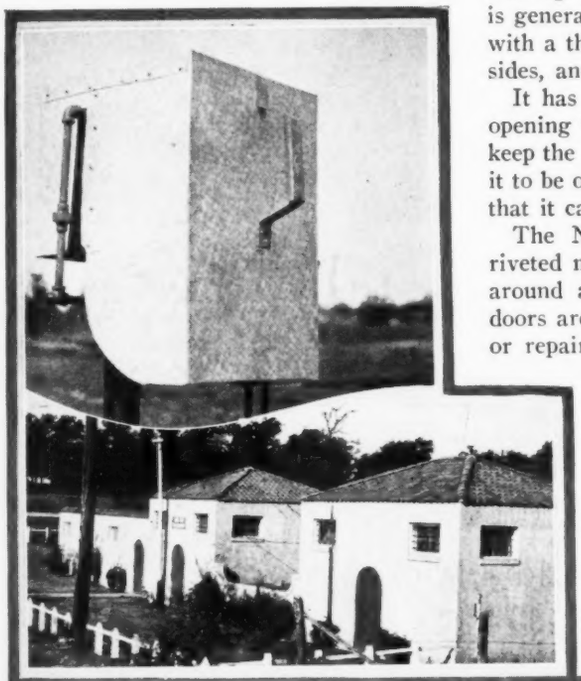
Weather Conditions Necessitate Many Types of Meter Housings

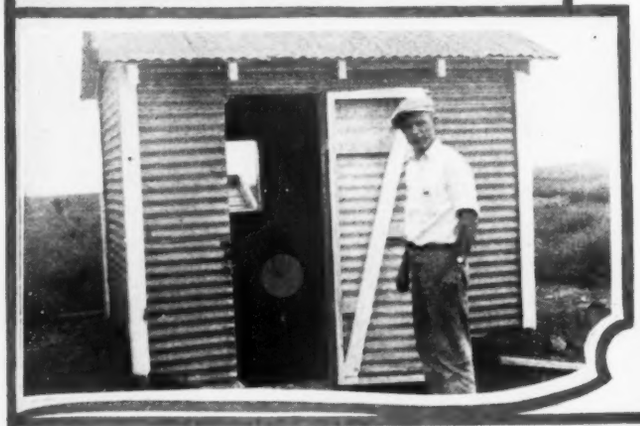
METER housings on individual installations have always been a source of annoyance, more or less, to the gas industry. Periodically the meter housing problem becomes acute, particularly with a snap of cold weather or during rainy weather. The result is that many types of housing are found over the country.

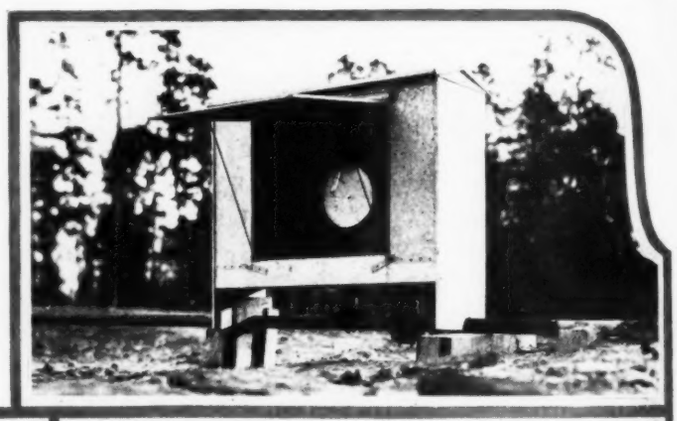
In Louisiana where rainy weather makes it difficult to change charts without getting raindrops on the ink lines and causing the ink to run, a type of house affording ample room for this condition is generally built. The Magnolia Gas Company protects its individual settings with a thin sheet metal covering, riveted together and hinged to open on three sides, and at the top.

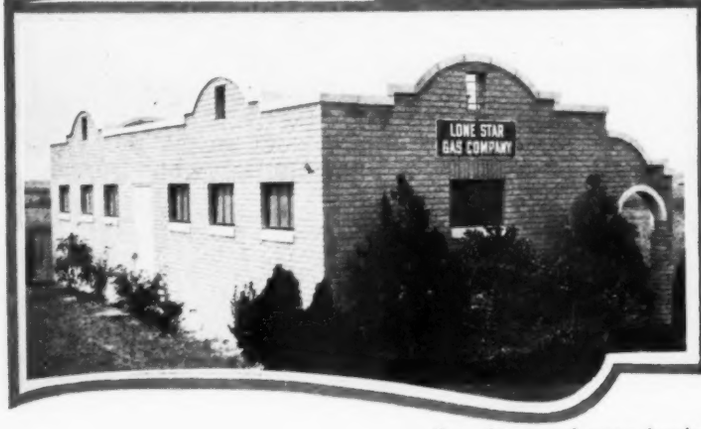
It has a circular glass in the front door, making it easy to inspect without opening the door. This door is protected at the top with a strip of metal to keep the rain out. One corner of the housing is equipped with hinges to permit it to be opened on three sides to make adjustments. The roof is also hinged so that it can be opened if necessary.

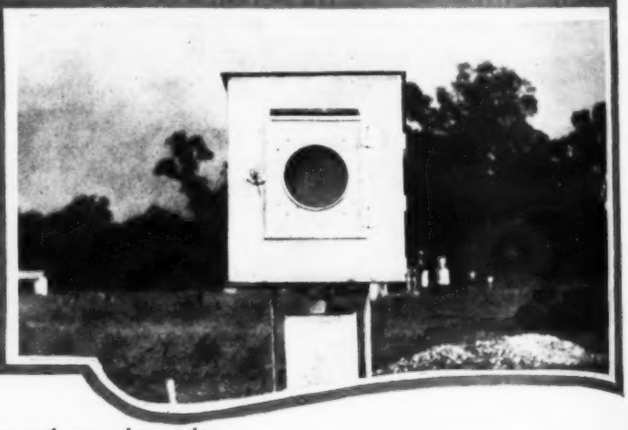
The Northwest Louisiana Gas Company uses an installation made with riveted metal which opens in the front and in the rear. The metal is shaped around a wooden frame which is set directly over the gas line. The two doors are held open by supports whenever it is necessary to make adjustments or repairs to the meter. In Oklahoma the Carter Oil Company uses a box-shaped galvanized metal covering that fits over the top of the installation. It is riveted together and because of the light weight it can be easily lifted by the handle. To change charts during rainy weather it can be lifted high enough and held at such an angle to prevent the rain from striking the chart. The Lone Star Gas Company of Texas has tried several different types of housings for individual settings, but invariably goes back to the more bulky type of frame and sheet iron constructed house. This company has virtually standardized on this type of housing. While it is not as attractive as the company would desire, that feature is sacrificed in order to afford more protection to workmen adjusting meters and changing charts.











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Use of Typical Power-Input Curves in

Counterbalancing Oil Wells

By A. L. FABER[1]

TWO views are held regarding the counterbalancing of pumping oil wells; first, counterbalance with regard to the power input, making it a minimum; second, counterbalance with regard to polished rod, making sucker-rod stress a minimum.

A compromise between these two views will most probably result in maximum pumping economy. However, each pumping oil well is a problem which will have to be solved on its own merits.

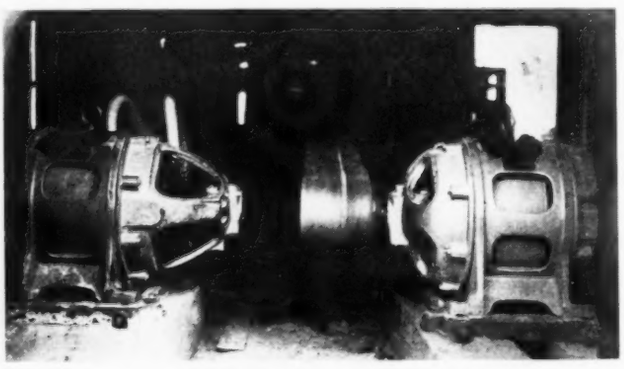
During recent months several papers have been written on counterbalancing pumping wells, a subject towards which much consideration is now being directed.

Mr. Faber's paper is the result of much study from a different angle of this problem.—Editor.

Development of typical power-input curves would seem to be a logical and simple way to attack the problem. For each field a composite power-unit curve could be developed. Where there are two or more producing sands, a curve would have to be developed for each sand.

While average values are always dangerous when applied to pumping oil wells, it has been found that wells pumping from the same sand and operating under approximately the same conditions are within a reasonable per cent of each other from a power-input standpoint, exceptions, of course, being made of crooked holes.

When the statement is made that all wells are different, the statement overlooks a reference point. The question of "different from what" must be answered, and it is suggested that a typical power-input curve will be a stride toward a reference base.



An electric motor in oil field service.

The main factors that vary the power-input curves are:

(1) Size of tubing
(2) Size of rods
(3) Size of lead lines (discharge head)
(4) Number of strokes
(5) Length of stroke
(6) Total amount of fluid (percentage of oil)
(7) Fluid level or total lift
(8) Efficiency of equipment
(9) Friction of system
(10) Natural period of vibration of system
(11) Counterbalance
(12) Condition of the well (straight hole or otherwise).

It is reasonable to suppose that the first ten factors will be within a narrow margin of each other after experience has shown the best way to operate the wells, and where a variation is noted the well can be "weighed" and the necessary correction applied.

The greatest variable in its effect on the power-input curve is the type and weight of counterbalance.

A typical example of the effect of the counterbalance on power-input curves is shown in the accompanying figure. These curves were taken on a Smackover second-sand well making 1,650 barrels of fluid, 120 barrels of which was oil. The well is approximately 2,400 feet deep, has a fluid level of 1,200 feet from bottom, and is equipped with 3-inch tubing, ¾-inch rods, 4-inch lead line, and a crank-type rotary counterbalance, operating at 29 strokes per minute, with a 72-inch stroke. Power is supplied by a 25/65 two-speed motor through a single reduction gear, and belt to bandwheel.

Curve No. 1 shows the power-input at well, operating with no counterbalance. This curve is plotted from the power-input curve taken with a 12-inch per minute recording watt meter and eight positions of the crank chosen arbitrarily. It will be noted that the maximum point is 87-KW or 116.6 H. P., while the minimum is 58-KW 7.7 H. P.

Curve No. 2 shows the power-input with the proper weight of counterbalance, but with the weights approximately 15 degrees behind the crank. It is noted that the peak hangs on for a good part of the stroke, and would cause the motor to burn out.

Curve No. 3 shows the power-input with the well properly counterbalanced from a power standpoint. Wells operating on this cycle have given a minimum of rod, belt and rig trouble, with a maximum of fluid lifted. It is of interest to note that belts on this cycle of operation have given remarkable results. One old belt with an 8-inch clutch cut has been in operation six months without a break.

Curve No. 3, therefore, is considered to represent the typical power-input cycle required for best operation. Curves taken on a number of wells pumping from the same sand coincide with this curve to within three to five per cent.

A further analysis of the curves shows that the thermal capacity of the motors are affected by the fluid and counterbalance peak, as maximum heating comes at these points. The time duration of these peaks is a most important factor. It is important, therefore, from a heating and efficiency

[1] Arkansas Power and Light Company.

Institute Over, Oil Men Are on Way Home Again

Next Year's Convention to Be in Chicago November 10-13

(Special to The Tribune)

CHICAGO, Dec. 6.—After selecting Chicago as the 1930 convention city at the final session here Thursday night, delegates to the tenth annual American Petroleum institute meeting here were on their way back home this morning.

The President's Special, carrying the Tulsa delegation, departed this morning and is due to arrive at the oil capital at 7:15 Saturday night.

The new executive committee, which governs the affairs of the institute, held its first meeting at noon Thursday. The committee is composed of E. W. C[illegible], Los Angeles; J. Howard Pe[illegible], Philadelphia; R. C. Holmes, Ne[illegible] York; W. C. Teagle, Ne[illegible] York; J. J. Byles, Pittsburgh, and W. B. F[illegible] Independence, Kan.

The pri[illegible] address of the annual ban[illegible] Thursday was delivered [illegible] S. A. Tits." [illegible] spoke on "Prop[illegible]

The Exchange National bank of Tulsa had the largest representation of directors of any one concern at the meeting. Exchange directors who attended the meeting here were: Harry H. Rogers, president; John H. Markham, jr., J. J. Larkin, Dana H. Kelsey, H. V. Foster, C. H. Sweet, C. A. Steele, E. H. Hanlon, E. B. Reeser, W. C. Franklin, Dan J. Moran, F. W. Bryant, T. A. Creekmore, Harry F. Sinclair and Earl W. Sinclair.

Next year the convention will again be held in Chicago on No[illegible] vember 10-13.

From The Tulsa Tribune, issue of Friday, December 6, 1929

"The Largest Representation of Any One Concern . . . ."

A thorough understanding of oil industry conditions has been the constant background of Exchange National Bank progress; and the breadth of that understanding was illustrated at the recent American Petroleum Institute meeting.

Attendance by directors of The Exchange National Bank exceeded attendance by directors for any oil company or other affiliated institution represented.

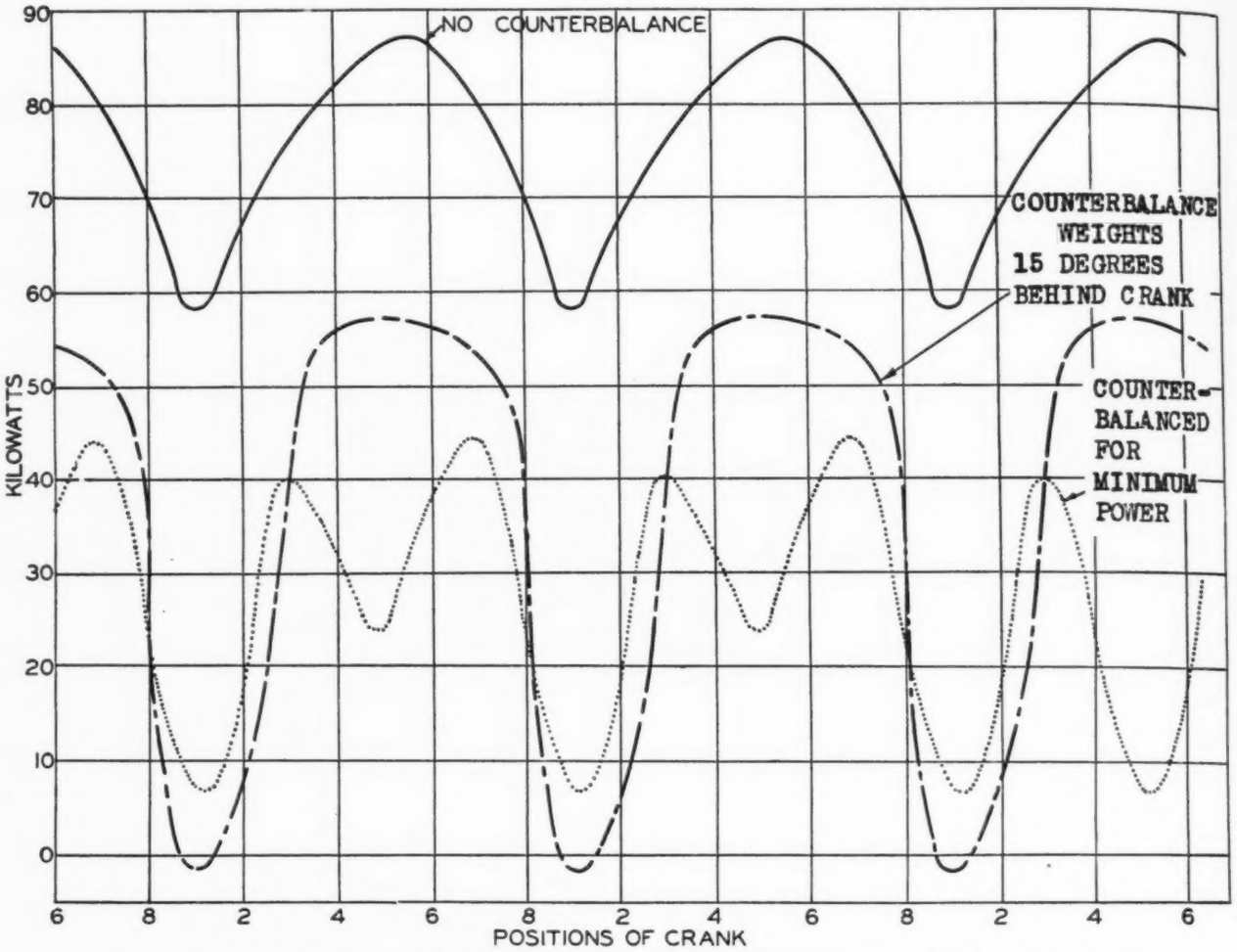
The character of their connection with the oil industry, requiring the presence of these directors at the industry's most important conferences, is substantial indication of the dominant position occupied by The Exchange National Bank.

Combined Capital, Surplus and Undivided Profits Exceed $10,000,000
Resources Exceed $100,000,000

EXCHANGE BANKS OF TULSA

The Exchange National Bank — Exchange Trust Company

standpoint, to look at the entire cycle of operation rather than the average. Typical power-input curves of operation taken under good counterbalance conditions will serve as a measuring stick for overall operation. They can be secured easily and with practically no shutdown time. They will indicate proper counterbalance, motor heating and the limit of motor to carry the load, and provide a basis for comparing surface equipment without the necessity of running it on a well, since a test taking points on the typical curve will give a sound basis of comparison.



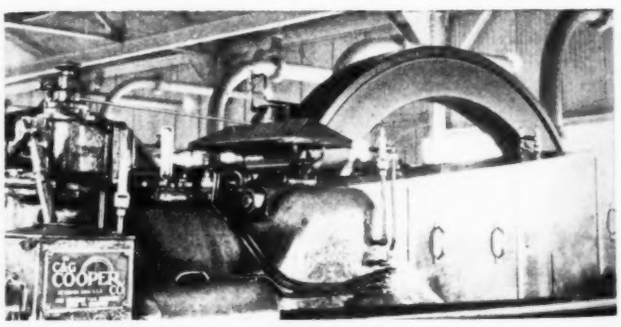
CURVES OF POWER INPUT TO PUMPING OIL WELL SHOWING EFFECT OF COUNTERBALANCE
SECOND SAND WELL IN SMACKOVER FIELD, ARK. DEPTH, APPROX. 2,400 FT.; 3-INCH TUBING; ¾-INCH SUCKER RODS; STROKES PER MINUTE, 29; LENGTH, 72 INCHES; LEAD LINE, 4-INCH DIA.; TOTAL DAILY FLUID, 1,650 BBLS.; OIL, 120 BBLS.; FLUID LEVEL, 1,200 FT. FROM BOTTOM; CRANK TYPE ROTARY COUNTERBALANCE PUMPING OFF BOTTOM.

AN engineer at a Magnolia Gas Company compressor station wiped the thin film of oil sprayed from the breather off his engines, and was relieved from duty for lunch. As he bumped his way over a country road to his favorite restaurant in one of the millions of that well-known makes of "small but speedy" vehicles, his mind was occupied with one thought. That thought was some method to eliminate the small spray of oil on his engine.

It is reported one of the oilers at the station after giving up trying to evolve a method of eliminating it, had figured out how many miles of wiping could be eliminated daily if that spray could be stopped. Likewise, he visioned more tidiness in an already neat station.

The engineer carried his thoughts on into the restaurant, and as he watched the vapors rise from the restaurant stove, the solution to his annoying problem unfolded itself. Which goes to prove that restaurants, after all, have their moments, in spite of tough steaks. If the type of screened canopies over those stoves caught the vapors and drained them off through a tube, why couldn't the same principle be used for his engines, he mused.

At the shops the next day the mechanic started constructing a canopy similar in design to those used in restaurants to go over the breather. Screen mesh was secured inside the canopy, about a quarter of an inch away from the top. Drain pipes were put in either end of the canopy, and gutters fitted around the bottom of the slope and on the inside. Drain pipes on either end were connected to the gutters, and inserted just inside the breather.



When the engine was started, the fine spray from the breather was sent up into the pan. The drops of oil collected on the mesh and either dropped back into the breather or else drained back into the breather through the gutters and two drain pipes on the end of the canopy.

There's a Field-Proved Reason for Every Elliott Feature

Materials

The special materials used in the manufacture of Elliott Core Drills is an important feature which does not escape the attention of experienced field men. For it is a well known fact that a certain type of material, even when of the finest quality and suitable for certain purposes, may prove a complete failure in other classes of service.

Selection of material for each individual part of Elliott Core Drills has been made after exhaustive tests in the laboratory and in actual field service, extending over a period of many years. These tests have proved conclusively that a certain material invariably proves better for a certain part, and *that* material is used in Elliott Core Drills regardless of cost or expense in manufacture.

The extreme care used in the selection of materials, together with perfected design, result in the elimination of lost time, repairs, replacements and other expense which follow the use of inferior and *cheaper* equipment.

Elliott Quality insures that Elliott Cores cost less per foot of core recovered.

The Elliott Core Drill for Rotary Tools.

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850 Subway Terminal Building
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Export Office:
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ELLIOTT Core Drills

When writing Elliott Core Drilling Co. *please mention The Petroleum Engineer*

Gasoline Plant Equipped for Making Gas from Petroleum Fluids

By C. R. BURKE[1]

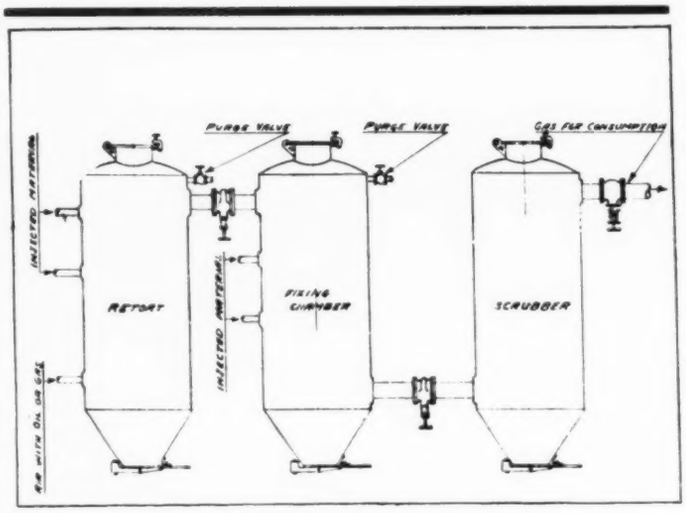
DURING the past year in a plant of one million cubic feet daily capacity gas was manufactured by both the means of partial combustion and injecting into the hot gas so produced either the same or other substances from petroleum sources to increase both the b. t. u. per cu. ft. of the gas and obtain liquids suitable for motor fuel and other purposes.

The plant was built to operate either at practically atmospheric pressure or as high as 50 pounds. Higher pressure may be used if desired.

The raw materials utilized were casing head gas, residue gas, butane, a so-called mineral seal oil, and natural gasoline containing various percentages of butane and small percentage of propane.

Mineral seal oil, used for cooling, washing and carburetting was also again utilized for gas making, and from such operations it was judged that even residual fuel oil could be profitably employed, especially as the U. G. I. has a "Heavy Oil Nebulizing System", which makes possible the use of such oil, containing as high as 10 to 15 per cent of coke, for carburetting.

It was found that the process described was capable of competitive use, both for industrial installations, and domestic use in many selected communities (especially in those to which a refinery is adjacent), as a sole source of artificial gas or as an auxiliary to present facilities.



This Flow Chart shows in general the following gas making operations: Petroleum fluid mixed with air is fed into the retort, ignited and partial combustion maintained. When the gas desired for that operation is obtained, additional material may be injected at various points, either in the retort itself or the "fixing" chamber or both to produce the required gas for consumption and liquids. From the "fixing" chamber the gas passes to the scrubber where the liquids are removed and the cleaned gas ready for consumption.

Gas may be produced of, practically speaking, any b. t. u. per cu. ft. that may be desired for commercial use to compete with gas manufactured from other substances and even natural gas under some conditions.

The b. t. u. efficiencies of this process, based on the b. t. u. of the raw materials used for gas making, and the finished gas produced, are, at present, approximately as follows:

Natural Gas	from 90 to 95 per cent
Refinery Gases	from 90 to 95 per cent
Butane	from 85 to 90 per cent
Natural Gasoline	from 85 to 90 per cent
Gas Oil	from 70 to 80 per cent

The specific gravity of the gas produced from the raw materials named, excepting that of gas oil, was similar to that of water gas carburetted with butane, as reported by the Bureau of Mines, and, should not appreciably affect the capacity ratios of existing distribution equipment.

The gas making equipment can be used interchangeably for the conversion of natural gas and refinery gases, or manufacturing gas from propane, butane and natural gasoline, or the production of oil gas, utilizing the sensible heat of the gas for carburetting or "cracking".

As the gas making and injection apparatus are brick-lined, any carbon or coke formations are readily removed, usually by "purging," and the "upkeep" cost is decidedly low.

Operations easily regulated to produce desired results are then practically automatic.

In addition to the large plant first herein mentioned, a small one was built to demonstrate the commercial possibilities of operating upon gases containing hydrogen sulphide by submitting a portion of same to partial combustion and oxidation, thereby converting the hydrogen sulphide to sulphur dioxide, washing the gas so produced with water, utilizing the sulphur dioxide solution so obtained to wash fresh gas, containing hydrogen sulphide, and thereby removing the hydrogen sulphide and precipitating sulphur.

The plant was operated upon casing head gas and the above results obtained, and it was also found that due, probably to polymerization, at least 60 per cent of the liquid content of the original gas of a heavier baume gravity could be obtained by the first operation.

Such a process appears to hold promise of commercial use both for casing head gas, natural gas, residue gas, refinery gases, and other gases containing hydrogen sulphide.

The plant of one million cu. ft. daily gas making capacity proved that a new market for natural gasoline and butane lines at the door of the natural gasoline manufacturer.

He can either produce butane free gasoline at his plant and convert the butane into gas and liquids suitable for motor fuel having high "anti-knock" qualities, and other products, now usually produced from coal, or he can ship his butane or natural gasoline, similar to Grade C, to selected points where the gas made from both may be sold.

He can also rectify the natural gasoline at the location where the manufactured gas is to be sold, thereby obtaining a butane free gasoline for sale in the same and adjacent territory.

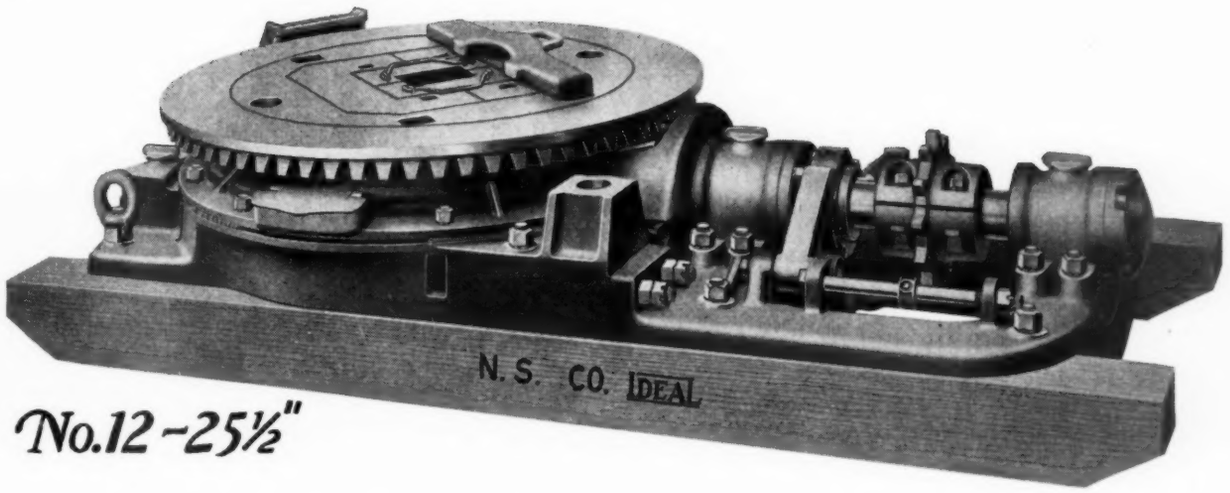
The producer of crude petroleum may manufacture gas to supply same either for repressuring or other uses.

The refiner can supply gas of practically any desired b. t. u. required for consumption in his own city.

The natural gas company can at a "city gate" convert

[1] Whealton & Townsend, Inc.

IDEAL Rotaries



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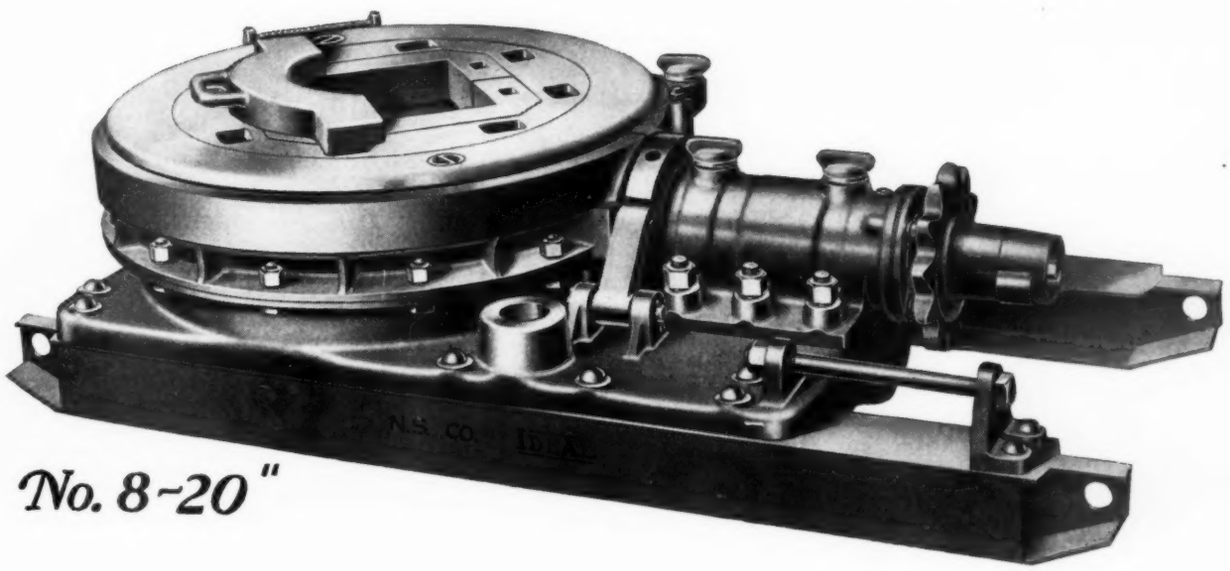

No. 8 - 20"

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part of its natural gas into a gas of lower b. t. u. per cu. ft., with increased volume, that depending upon the b. t. u. of the gas made, thereby regulating the b. t. u. of the gas supplied, say to 850 b. t. u. per cu. ft., enabling it to both conserve gas, and if it is short of gas, it can, by substituting oil as raw material in the place of natural gas, quickly supply gas to aid in caring for its "peak load".

Apparently as these long natural gas transmission lines increase in number some such procedure must some day be followed out, and the sooner it is done the better for all concerned.

At Hornell, New York, converted natural gas and oil gas is used, as desired with natural gas. At Olean, New York, refinery gases converted and used with natural gas.

In each case only partial combustion of the raw materials being employed for the gas making.

At the last meeting of the American Petroleum Institute in Chicago the over-production of gasoline was stressed with the consequent great increase in stocks placed in storage during the past year.

It was suggested that refiners must cut down "runs" until the surplus is disposed of, and thereafter, "run" so that the present overstock of gasoline will not occur.

Such procedure will undoubtedly decrease the use of natural gasoline, which, practically speaking, must be produced each day, and which the last Bureau of Mines report shows has lately increased some 250,000 gallons per day.

Stabilizing plant for pressure still distillate. (Courtesy C. F. Braun & Co.)

As it is reported that two large natural gas lines are to be constructed to transport natural gasoline from the Appalachian fields to the eastern seaboard, the following three examples are presented to give an idea of what might be done in that field both to conserve the natural gas and decrease the output of natural gasoline. A 1929 survey gave the amount of natural gasoline produced in those fields as 597,478 gallons.

If 597,486 gallons of natural gasoline converted into gas of approximately 520 b. t. u. per cu. ft. and 5 gallons required per 1,000 cu. ft., the gas produced would amount to 119,497,000 cu. ft. per day.

Cost

119,497,000 cu. ft. 2 cents per 1,000 cu. ft.	$2,389.94
Pumping into main lines at 3 cents per 1,000 cu. ft.	3,584.91
Total	$5,974.85

Financial Returns

If the mixed gas sold at 35 cents per 1,000 cu. ft.

119,497,000 cu. ft. at 35 cents per 1,000 cu. ft.	$41,823.95
Less cost	5,974.85
	$35,849.10

597,486 gallons used, approximate return per gallon 6-3/100 cents.

If the gas sold at 40 cents per 1,000 cu. ft., additional receipts $5,974.85 per day, making the return per gallon approximately 7 cents per gallon.

If the daily production of natural gas in the Appalachian field is as it has been stated to be, namely, approximately 350,000,000 cu. ft. per day, and the b. t. u. per 1,000 cu. ft. figured as 1,000, the mixed gas will be approximately 900 b. t. u. per cu. ft., and the gas comparable with natural gas.

Figuring the butane in the natural gasoline as 20 per cent, if that removed and converted into gas, and a butane free gasoline produced, the amount of butane available would be 119,497 gallons.

If the butane converted into gas of approximately 520 b. t u. per cu. ft. and 5½ gallons required per 1,000 cu. ft. the gas produced would amount to 21,727,000 cu. ft. per day.

Cost

21,727,000 cu. ft. per day at 2 cents	$ 434.54
Pumping into main lines at 3 cents per 1,000 cu. ft.	651.81
	$1,096.35
If the mixed gas sold at 35 cents per 1,000 cu. ft.	$7,604.45
Less costs	1,096.35
	$6,508.10

119,497 gallons butane used approximate return per gallon 5-78/100 cents.

While the butane free gasoline should be worth approximately 3 cents per gallon more than the market price for natural gasoline, which on the 477,989 gallons amounts to $14,339.67 per day.

If, at present, there is left in the natural gas about the same amount as in the natural gasoline, that could be extracted and converted into gas, producing some 21,727,000 cu. ft. gross, net 17,913,096 cu. ft. per day, and increasing the revenue from butane on the same price basis for gas sold as in estimate No. 2, namely, about ($6,508.10-$1,334.55) $5,173.55 per day.

While in the foregoing estimates the raw materials utilized are natural gasoline containing butane, and butane in the same conversion apparatus natural gas itself may be the raw material or gas oil, or residual, fuel oil.

In the foregoing the gas making cost has been estimated as somewhat lower than if the gas was made at plants to which the natural gas or butane must be shipped.

As the producers of crude oil now work together under existing laws it appears that the manufacturers of natural gasoline may do so both to obtain this market for gas, and stabilize their marketing situation, making them as free as possible from the hitherto constant see-saw between supply and demand.

Australian road builders are experimenting with a new paving material made from oil shale.

The Effects of Controlled Pressure on

Flowing Oil Wells

(Concluding Paper)

By **I. B. WILLIAMS**

THE design of any device or the operation of any process for flowing oil wells should incorporate certain principles discussed in a previous paper in order to be successful in securing (a) normal daily production, (b) retardment of water encroachment, (c) decrease in gas-oil ratio and (d) increase in ultimate production.

In Figures 3 to 6 are shown the details of an oil well flow device, the design of which incorporates these principles of pressure control which are necessary to secure the results (a), (b), (c) and (d), as explained in the following discussion, accompanying which are the results of tests over long periods under actual field conditions.

Obtaining Normal Daily Production

The fluidity of the oil at and near the face of the sand is increased by the proper regulation of back pressure resulting from imposed restriction in the flow line at or near the face of the sand.

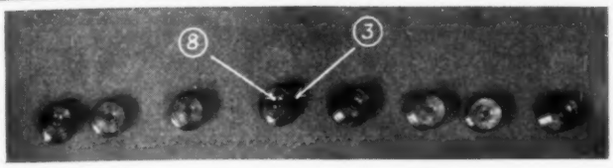


Fig. 6

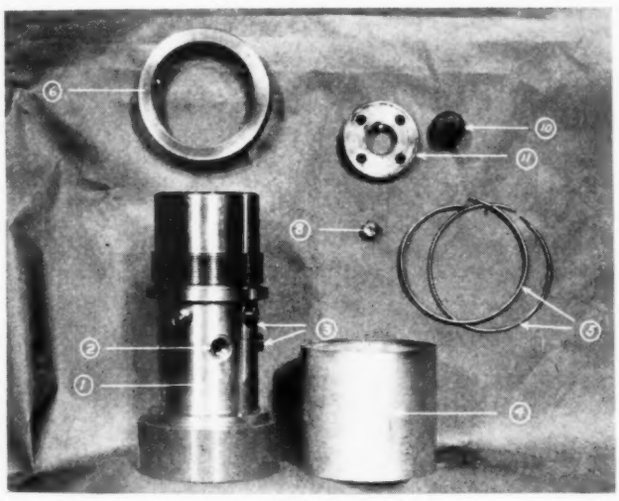


Fig. 3

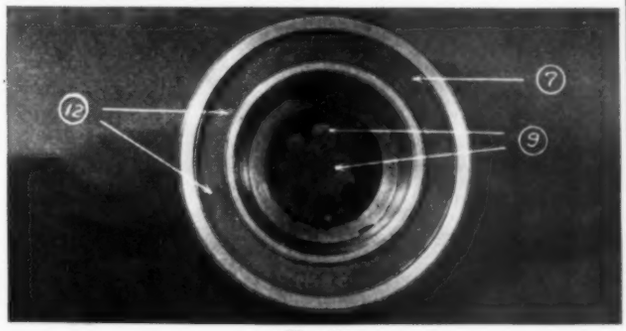


Fig. 4

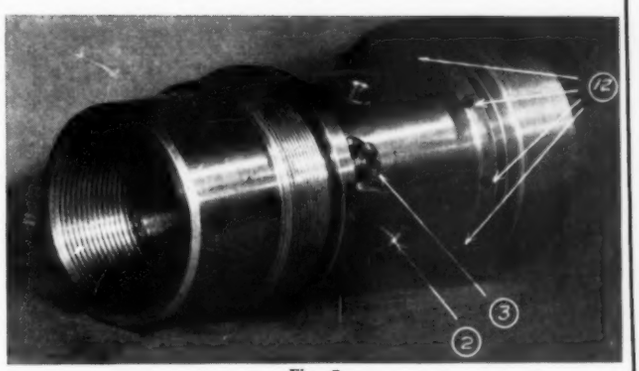


Fig. 5

A constant uniform flow of a portion of the natural gas is admitted into the flow tube, independent of the oil inlet of the flow tube. This flow of gas serves three purposes: First, it insures a proper mixture of the oil and gas prior to flowing; second, it creates a steady piston flow in the flow line, and third, it acts as a governor on the entire mechanical structure to maintain uniform flow, prevent long heading, and insure the maintenance of a constant casinghead pressure.

Retarding Water Encroachment

The application of back pressure imposed by restricted oil flow reduces the differential flowing pressure from the oil sand reservoir to the sand face or the bottom of the well. The amount of back pressure which may be applied without reducing the daily normal oil production is far in excess of that amount necessary to prevent the flow of water toward the well. Water does not absorb gas except to a limited extent. There is no change in fluidity of the water, hence the flowing characteristic is unaffected by increased static pressure. The change in the differential flowing pressure affects only the quantity of water flowing per unit time.

Decreasing the Gas-Oil Ratio

In order to reduce the gas-oil ratio, the oil must be admitted into the flow line at a rate of flow which is no faster than the sand can deliver it under the conditions of equilibrium which should exist between the fluidity of the oil and the differential flowing pressure.

These conditions obtain when, due to the imposed back pressure, the fluidity of the oil sand is raised to a maximum by absorption of natural gas and lighter fractions at the same time that the differential flowing pressure from the formation to the sand face is decreased to a minimum.

There is a critical point in the application of back pressure when the delivery of oil from the sand is a maximum and the gas-oil ratio a minimum. The delivery at such a critical point in the flowing life of an oil well occurs when the sand is first tapped.

Thorough mixture of the oil and gas before resolving itself into alternate pistons of oil and gas is considered by the writer of *especial* importance to insure a minimum gas

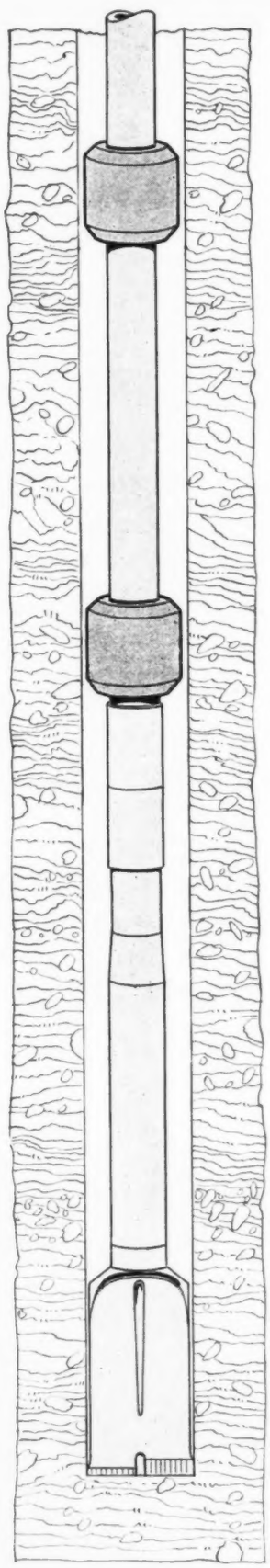
ANOTHER BETTIS SUCCESS

Keeps Drill Centered

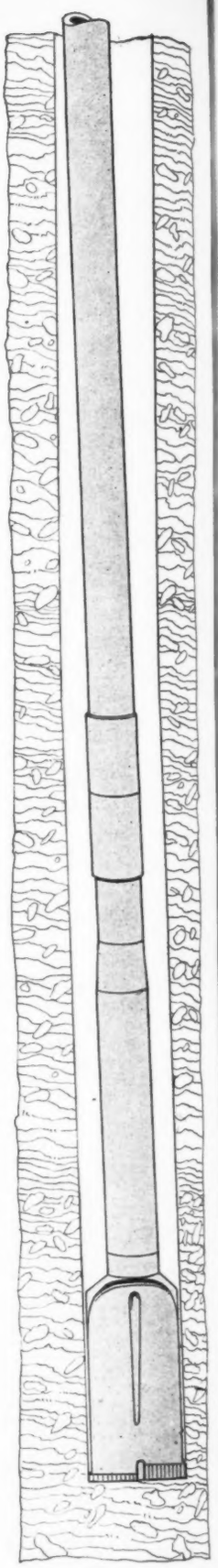
Keeps Hole Straighter

Relieves Vibration

Group photograph of various Bettis Products. The smaller rubbers are the 5″ Bettis Protectors. The medium size are 12″ Bettis Drill Stabilizers. The largest size is of Bettis Core Barrel Guide.



Drill stem showing two Bettis Drill Stabilizers in place, preventing wobble and excessive vibration of the drill and string.



Illustrating a drill string without Bettis Stabilizer, encouraging twist-offs and crooked hole.

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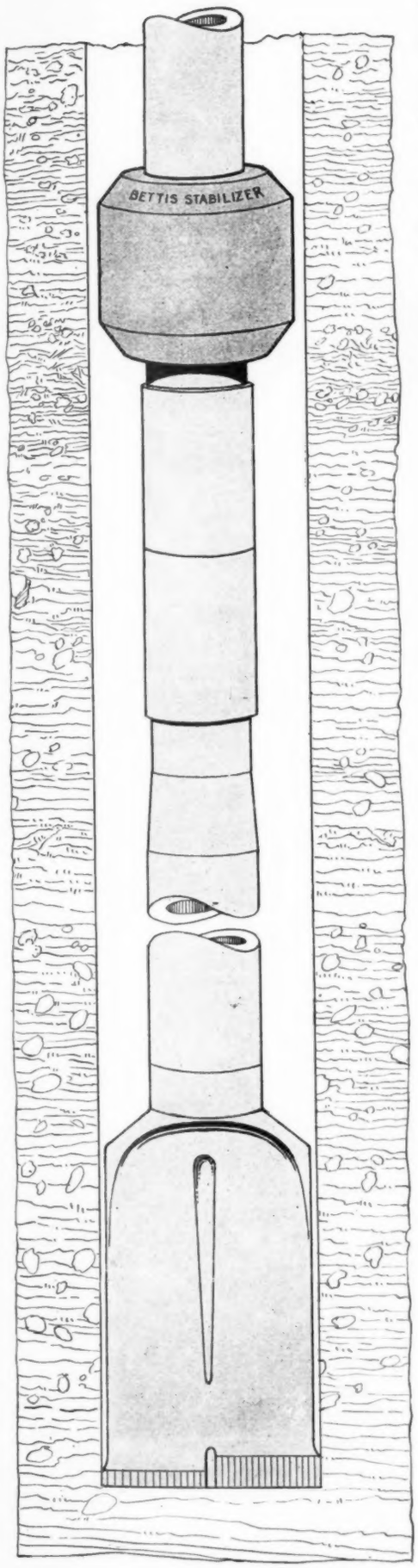

Illustrating Bettis Drill Stabilizer in position immediately above the collar.

BETTIS DRILL STABILIZERS

The greatest whip in the drilling string occurs just above the drill collar. The vibration and corkscrewing of the string in open hole is a principal cause of twist-offs and crooked hole. To overcome this problem and to offer support to the string so that it will retain its vertical position, Bettis Drill Stabilizers were designed. They have won the immediate acceptance of hundreds of drillers.

These Stabilizers are identical to Bettis Protectors in quality and design—simply larger in size to pass through casing ranging from 9⅝″ to 20″ inside diameter. The size mostly preferred is 10″ O. D. to fit 6″ drill pipe.

Bettis Drill Stabilizers are installed just like Bettis Protectors. They should be used in open hole from the bottom of the casing to the top of the drill but the vital place is on the drill stem and first stand of pipe where the greatest "hinging" occurs.

Companions of Bettis Protectors

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factor. In the flowing life of an oil well the mixture of oil and gas is very nearly perfect at the moment the reservoir is tapped, but seldom thereafter under open flow methods. The unbalanced condition rapidly becomes worse until the well ceases to flow naturally, even when there is yet sufficient gas and gas pressure in the structure.

The proper balanced condition can only be brought back and maintained by mechanical means. This involves a readjustment of the oil, gas and gas pressure throughout the formation, or what might be termed a repressuring and refilling of the depleted area by the movement of oil and gas from undisturbed areas of the structure into the depleted area, together with a redissolving of the heavy residue oil in the depleted area which was deposited by the open flow drainage of the lighter constituents of the oil.

Problems of oil field transportation similar to that pictured above are often encountered in construction work. Eight teams of horses are shown hauling a big oil engine to its future home.

Increasing Ultimate Production

Increased economical ultimate production is believed to be a natural result if wells are produced as herein advocated. Artificial stimulation and unrestricted open flow under high gas factor, while it increases daily production for a short time, also is the surest way of insuring minimum ultimate production from a well or a structure. Such artificial stimulation, in the final analysis, serves merely to rob some of the oil reserve very rapidly, with the detrimental effects of water encroachment, depletion of the gas and gas pressure at and near the face of the sand, and effective plugging of the pores with heavy viscous residue oil from which the lighter constituents have escaped.

It readily can be appreciated that the problem of flowing oil wells is not merely a problem of raising the accumulated oil out of the well hole, which is in itself a comparatively simple matter. The successful solution of the problem is to insure that the economic maximum amount of oil will be obtained from the formation. The problem, therefore, must be considered as a flowing problem from the sand reservoir all the way to the top of the ground. A completely balanced condition must be maintained, all phases of which, from the sand reservoir to the top of the ground, are in equilibrium. It is manifestly impossible to maintain such a balanced condition by having even a single phase in the entire cycle, such as irregular flow, excess back pressure, minimum back pressure, excess or minimum differential or minimum fluidity, out of balance.

Results of Field Tests

The results of a number of controlled pressure flowing tests on oil wells which follow were made with the oil well flow device already mentioned and illustrated.

Franz No. 3 (Magnolia Petroleum Co.), Wewoka, Okla.

The Franz No. 3 is a Wilcox sand well, drilled to a depth of 4,085 feet.

Average gas-oil ratio on open flow, 1,100 cu. ft. per bbl.

Average monthly rate of decline, open flow, 15 per cent.

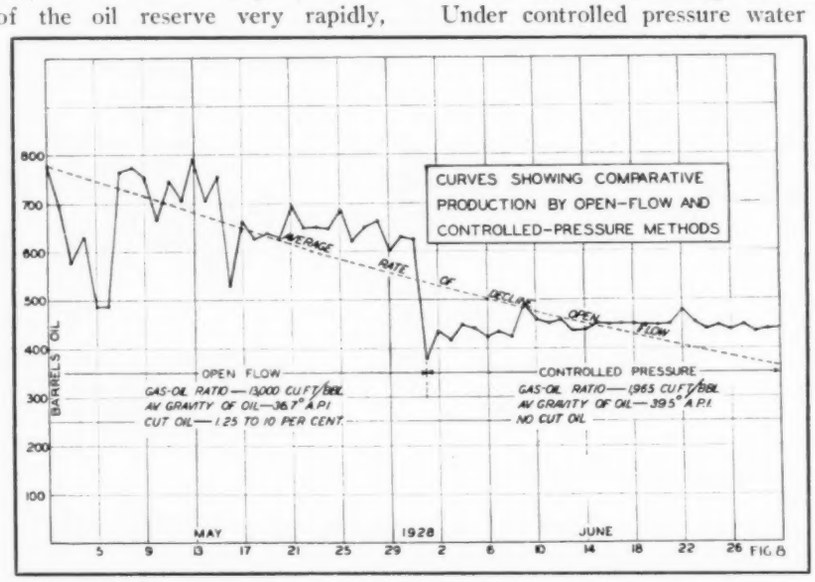
During the month of January, 1927, a 28-day test was run to ascertain the average daily production prior to the installation of the controlled pressure flow device, with the following results:

Average daily production of oil, January 1-28, 1927, 515 barrels.

Water and emulsion (estimated), 10 per cent. Gas factor (estimated), 1,100 cu. ft. per barrel.

Figure 7 shows graphically the variation of the daily production of 515 barrels, also the more uniform daily production of 840 barrels average under controlled pressure with the flow device during February.

Under controlled pressure water production was completely stopped, while the gas-oil ratio for the month of February averaged 315 cubic feet of gas per barrel of oil.



Pressure readings were taken with a recording pressure gauge, and the gas volumes measured with an orifice meter, both instruments having been tested for accuracy just prior to installation.

The results obtained with controlled pressure over a period of 10 months are as follows:

Franz No. 3

Date	Bbls. Oil, Daily Aver.	Cu. Ft. Gas Per Bbl. of Oil	Water Prod.
February, 1927	840	315.5	None
March, 1927	883	301	None
April, 1927	669	Meter removed	None
May, 1927	555	Meter removed	None
June, 1927	638	Meter removed	None
July, 1927	610	Meter removed	None

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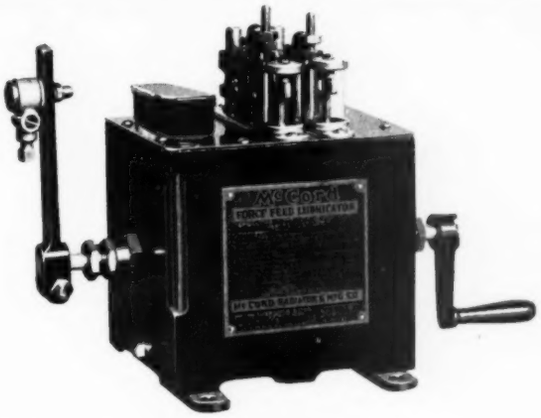
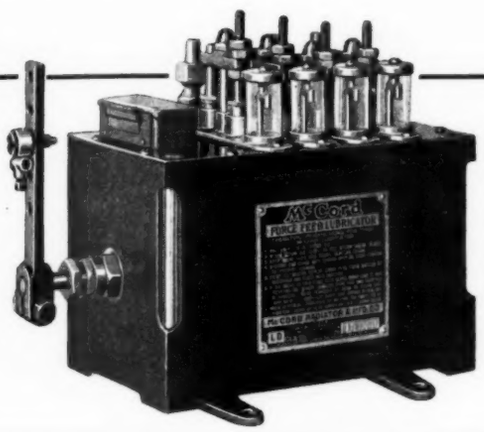
It's an inherent characteristic of McCord Lubricators to deliver minute quantities of oil against high pressures. The pumping units can be adjusted to deliver quantities of oil varying from a fraction of a drop to a constant stream. Adjustments once made remain unchanged. They are not affected by extreme temperature changes. They deliver the same quantity of oil, regardless of viscosity.





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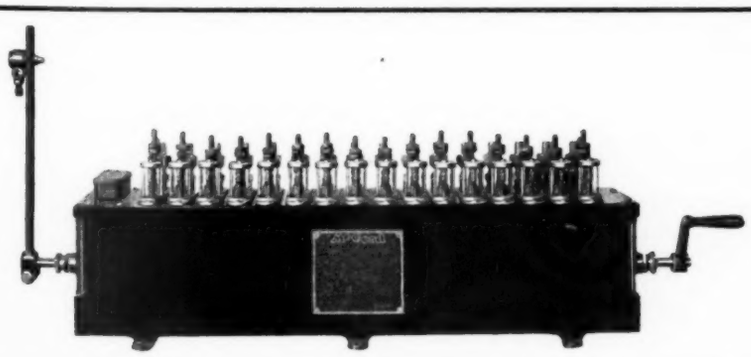

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August, 1927	638	Meter removed	None
September, 1927	540	Meter removed	None
October, 1927	484	Meter removed	None
November, 1927	375	Meter removed	None

On this well an examination of the records and production curves shows that:

1. Normal daily production was increased.
2. Water production was completely stopped.
3. Gas-oil ratio was reduced.
4. Ultimate production was greatly increased.

The well was produced during the 10-month period entirely on its own gas and gas pressure. One of the most interesting features was the increase in casinghead working pressure from 320 pounds to 370 pounds with a proportionate increase in oil production. On April 5, 1927, the casinghead pressure had reached 370 pounds and the oil production on that day was 928 barrels.

Mary Carter No. 1 (Barnsdall Oil Co.), Seminole, Okla.

Hunton lime well.

Depth, 3,920 feet.

Oil formation 20 feet thick.

Just prior to the application of controlled pressure with the flow device in the Mary Carter No. 1, an open flow or natural flow test was made for a period of 30 days, followed by a tubing packer test of 43 days. The table below gives the results of the natural and packer tests:

Date, 1927	Oil	Gas	Gas Factor	
July 28 to Aug. 28	223.6	290,887	1,319	Natural Flow
Aug. 30 to Sept. 30	197.8	337,012	1,733	Tubing Packer Flow
Oct. 1 to Oct. 13	173	290,355	1,678	Tubing Packer Flow

Water production on natural flow, none.

Water production of packer flow, 10 per cent.

Average gas-oil ratio on packer flow, 1,705.

The results obtained by controlled pressure with flow device over a period of 11 months show:

Average gas-oil ratio for the entire period, 778.

Gas factor at present date, 660.

Depth of flow device, 3,780.

Water completely stopped by operation of flowing device.

Torsey-Baker No. 2 (Magnolia Oil Co.), Welcetka, Okla.

Well drilled in 1923.

Depth of well, 3,100 feet.

Well being produced by swabbing and flow by long heads.

The Torsey-Baker well was the first well that controlled pressure with the flow device applied. A great deal of experimentation was carried on during 1926.

It is worthy of note that most of the tests used for this equipment extend over a long period of time, from a few months to nearly a year. In the opinion of the writer, a few days' test of any method on an oil well does not yield conclusive evidence of the merits of the method because of the extremely slow adjustment in the sand reservoir. It may also be noted that all the wells under discussion had practically reached the end of their natural flowing life, due either to water encroachment or pressure depletion in the sand area immediately surrounding the well.

An inspection of the records of these tests will disclose that in each case the following was accomplished:

A. Increased daily production over the method employed at the time of application of controlled pressure with the flow device.

B. Water production stopped.

C. The gas-oil ratio reduced.

D. Ultimate production greatly increased or indicated where sufficient time or length of record was not available.

Conclusion

In conclusion, it is emphasized that each well is an individual problem. No one set of conditions that operate satisfactorily in one well can be applied to another well and be expected to produce the same results. It would be a coincidence if they did. Each well has a different rate of open flow decline, even wells drilled into the same sand with the same amount of penetration. A well drilled slightly into a sand, as a rule, has a slow rate of decline. Each well has its own maximum delivery capacity from the sand and this very seldom can be compared with another well because there are too many variables.

It is therefore of extreme importance in applying pressure control with any flow device to ascertain the conditions likely to be encountered in making an installation and adjust the elements of the device to meet these conditions. Actual experience of handling flowing wells is necessary in order to secure results.

FIG. 3

Details of Kellogg-Williams Flow Device

(1) Body of flow device.
(2) Gas orifice plug seat (threaded for taper plug).
(3) Gas orifice tapered plugs.
(4) Cylindrical cover housing for covering and protecting gas orifice plugs and seats, seated on lead gaskets to prevent fine sand and debris from plugging gas orifices.
(5) Lead gaskets for cylindrical cover housing seats.
(6) Screw clamp for holding cover housing in place (threaded to permit tight seating on upper gasket and to hold housing cover firmly against lower gasket).
(8) Jewel mounted gas orifices in gas plugs.
(10) Oil choker.
(11) Oil choker threaded seat.

FIG. 4

Details of Kellogg-Williams Flow Device

(2) Gas orifice plug seat (threaded for taper plug).
(3) Gas orifice tapered plugs.
(12) Gas inlet holes drilled in body of flow device.

FIG. 5

Details of Kellogg-Williams Flow Device

(7) Screen cover over gas inlet holes (12) drilled in body of flow device.
(9) Gas-oil mixing chamber cup drilled and spot welded inside the flow device.
(12) Gas inlet holes drilled in body of flow device.

FIG. 6

Details of Kellogg-Williams Flow Device

(3) Gas orifice tapered plugs.
(8) Jewel mounted gas orifices in gas plugs.

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Observations Regarding the

Critical Velocity of Venezuelan Wells

By F. P. DONOHUE

THE subject matter of this paper is based upon work done upon flowing wells in the Maracaibo Lake Basin of Venezuela. The Lago Petroleum Corporation had extensive production in this area, gas-oil ratios were low, and the problem was whether by careful handling of the wells with respect to flowing conditions and conservation of the gas we could keep the wells flowing down to a point where an ordinary working barrel could handle the production, thereby avoiding the heavy cost of gas lift installation in the lake bed. The problem was also complicated by the nature of the wells themselves. Production is from soft comparatively unconsolidated sands, necessitating screen pipe in all wells. It was necessary to keep the wells not only flowing, but flowing without heading, as the relief of pressure upon making a head brought large quantities of sand into the well, sanding it up and possibly cutting out the screen pipe.

The substance of this article by Mr. Donohue was delivered orally before a recent meeting of the A. I. M. E., and has not been printed in any other petroleum publication.—Editor.

In furtherance of the plan of keeping wells flowing as long as possible, all wells were equipped with recording casinghead and tubinghead pressure gauges, separators were set at all wells, and about 50 per cent of the wells equipped with meters. All wells were tubed before bringing in. Frequent gauges were instituted. A large scale chart was kept for each well, showing daily oil and gas production, the gas-oil ratio, and the tubinghead and casinghead pressures. Any deviation from normal was immediately checked and the condition remedied if possible.

I. Theory of Flowing Wells

It is the writer's belief, based upon considerable investigation, that the flow of a well actuated by gas is mainly a question of velocity, a certain minimum velocity being necessary in the flow string to permit the gas to carry the oil. If this minimum velocity is not maintained, the oil drops back and the well heads or goes dead. The point of minimum velocity is of course at the bottom of the tubing, where the gas is under heaviest pressure and occupies the least volume.

Some years ago, when the success of the gas lift at Seminole was so pronounced, there was considerable broadcasting of the statement that a well had three stages of life,—the flowing stage, the gaslift stage, and the pumping stage. The theory of the gaslift stage was based upon the fact that natural flow was usually followed by a heading period, this heading being supposed to be due to decline of pressure in the reservoir or decline in the gas-oil ratio or other causes. However, gas-oil ratios usually increase with the life of a well up to a certain point. The fact seems to have been almost completely overlooked that as a well declined in production even with an increase of the gas-oil ratio, there was a decline in total volume of oil and gas which diminished the velocity in the flow string, and that the velocity might be correlated with the well's flowing life.

The Amerada at the time had a flowing well in Central Texas upon which it was decided to experiment. The well had been drilled in through 5⅜ casing for 500 barrels per day. It flowed up to about 300 barrels, started heading, and died. According to the old theory, it now needed artificial help to flow. However, we decided to try out the velocity theory. Upon running a string of three-inch tubing and giving one pull of the swab to lighten the fluid load, the well resumed steady flow. When the velocity at the bottom of the three-inch approximated five feet per second, heading again occurred and the well died. We then ran two and one-half inch tubing; the well flowed again until the velocity approached five feet per second. We then ran two-inch tubing, and then one and one-half, the well finally dying in the one and one-half at sixty barrels per day, which had a minimum velocity of about five feet per second. We were tempted to run a string of one inch, but decided to put the well on the pump. Since then, we have used one inch in Venezuela, the well flowing quite steadily at fifteen barrels per day.

Further experimentation upon flowing wells has made it apparent that velocity at the bottom of the flow string is the main controlling factor in the flow of oil wells flowing by gas. This velocity varies with the viscosity and other

Headquarters of the Lago Petroleum Co., Maracaibo, Venezuela.

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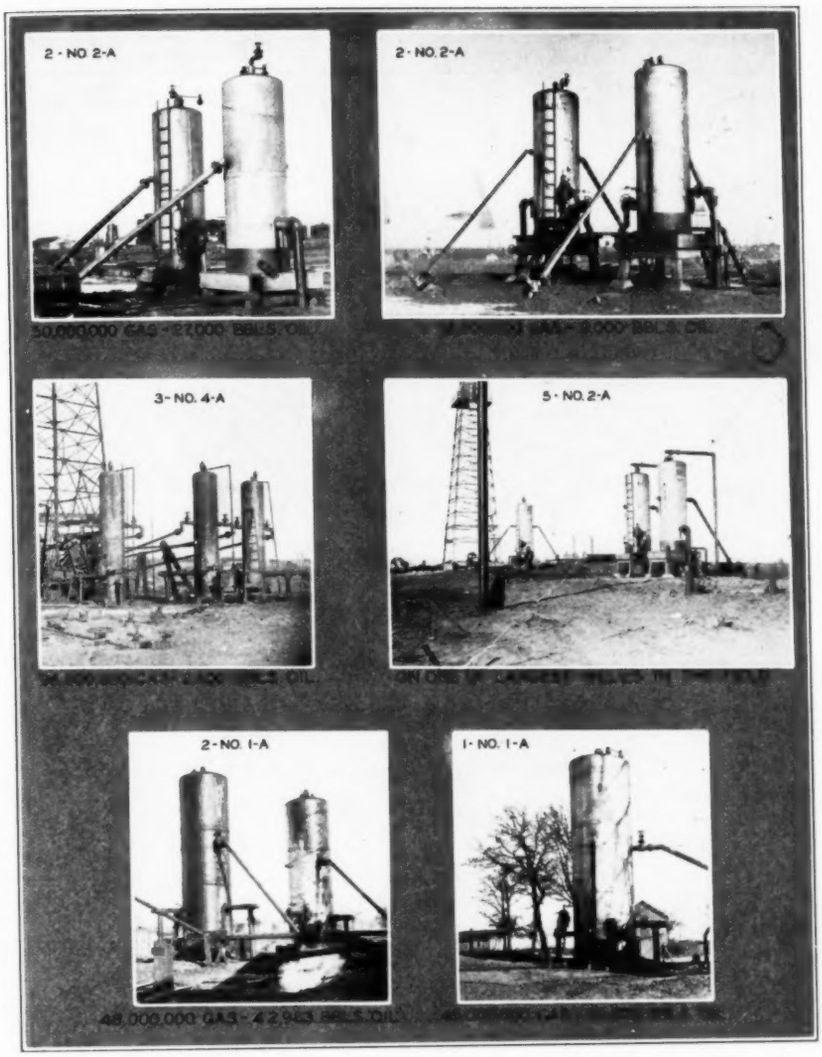

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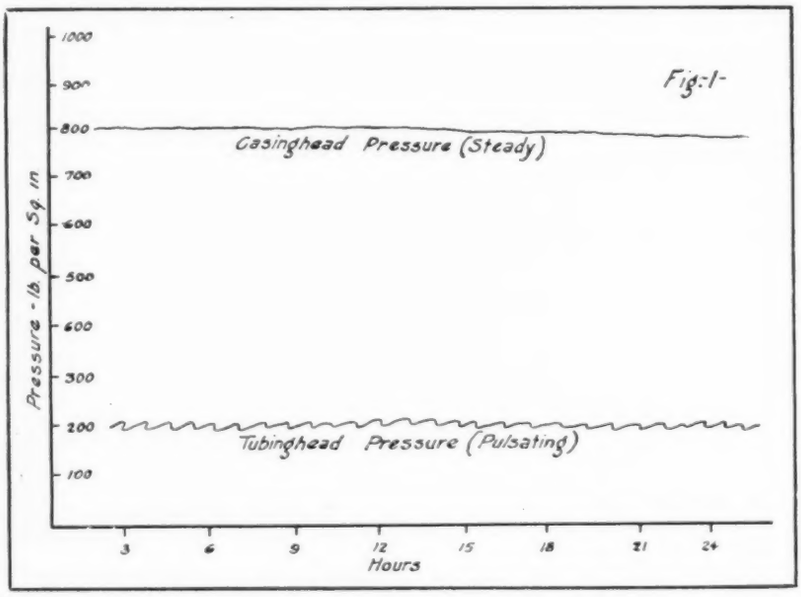
qualities of the oil,—in one of our Venezuelan heavy oil fields this velocity is only 1½ feet per second. In other fields, where the oil is considerably less viscous, the minimum velocity is between 4 and 5 feet per second. Repeatedly we have found that wells showing a tendency to head were at this critical velocity, and that by enlarging the choke, thereby permitting the gas to expand, occupying greater volume and increasing the velocity, the heading disappeared. On the other hand, we have found that wells which flowed steadily began to head as soon as choked to that point where the flowing velocity approached the minimum critical velocity of 5 feet per second.

II. Pulsating Wells

We were trying to do two things with our wells. First, we wanted to keep the wells flowing over to the pumping stage to avoid the installation of gas lift equipment. Second, we desired to keep the wells flowing without heading to avoid injuring the wells by pulling in excessive sand.

The first type of well we ran across was what we called a pulsating well. In these wells, the casinghead pressure was constant, but the tubinghead pressure fluctuated (see Fig. 1). This was due to separation of oil and gas within the flow string, the oil building up the tubinghead pressure as it went through in slugs. As the casinghead pressure, the indicator of pressure on the face of the sand, was regular, we let these wells go on in this fashion, as no harm was being done by the separation in the tubing.



III. Wells With Excessive Tubing Velocities

The next type of well encountered was that in which while flowing practically steady made four or five heads during the twenty-four-hour period superimposed upon the steady flow. Pressure charts for twenty-four hours resembled in general the pressure curves in Fig. 2.

Investigation showed that the oil in these wells was very viscous, and that tubing velocities ran as high as 20 feet per second, excessive for wells of this viscosity. What was occurring was that due to the size of tubing used, 2½-inch, there was insufficient venting area. Pressure accumulated in the casing behind the tubing, cutting down production due to increased back pressure, until that pressure became so great as to clean the tubing. This accounted for the four or five heads imposed on the steady flow.

Since excessive velocity was evidently the cause, an attempt was made to turn the flow through the annular space between the tubing and the casing. This space, 8¼ by 3, was too great, however, and the wells would not flow. They were therefore turned back through the tubing and sufficient gas bled off through the casinghead to reduce the velocity through the tubing. The wells thereupon stopped these heads. Some of the wells, however, made some oil through the casing, and as this was undesirable the casingheads on these wells were shut in and the wells allowed to continue heading.

As soon as these wells had declined in production to such a point that their flow velocities approached normal, they also stopped heading and flowed normally.

IV. Wells With Suitable Tubing Velocities, But Out of Time

The third type of well, and the ones needing the most careful handling, were the wells which we characterized as being "out of time". These wells had sufficient gas to give them a good flowing velocity, but, for a reason not immediately apparent to us, would surge or head. The cause was finally traced back to the effect of the large volume chamber between the tubing and the casing. Something in the well or at the tubing head would get this volume of gas to pulsating widely. This produced a surging effect in the flow string, and when it became wide enough, got the well to heading badly. We found that by pulling the tubing and running a packer, thereby eliminating the volume chamber, the wells went back to steady flow. However, this was considerable trouble, and we looked about for an easier method.

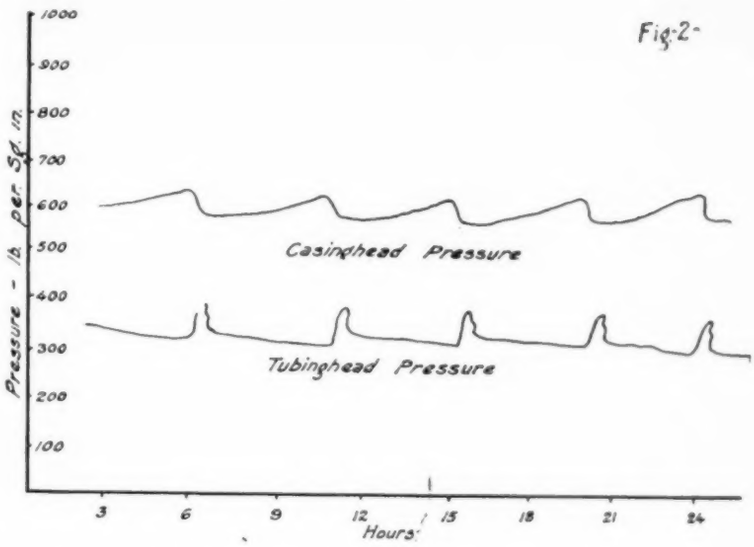
Venezuela Oil Concessions Properties, Cabimas, Venezuela.

Apparently once the column of gas got surging back of the tubing, the condition kept getting worse and worse, eventually causing the well to head, and perhaps to cease flowing altogether. During the head, gas escaped from behind the tubing into the flow string in large quantities, thereby reducing the pressure behind the tubing to such an extent that gas went into the annular space instead of into the flow

string, causing a dead period until the pressure had built up sufficiently. The older and smaller the well, the greater time it took to fill the annular space, and the greater time between heads.

We accordingly figured that if we could keep the gas from escaping from behind the tubing on surges or heads we could get the wells steadied down again. Bottom hole chokes were suggested, but were discarded because of the difficulty of adjustment. Adjustable chokes for the Christmas tree were found to be successful. When a well got "out of time," as indicated by a surging or heading condition while there was still ample gas for velocity for steady flow, an adjustable choke was placed in the Christmas tree. A production foreman then waited for a head, as indicated by the tubinghead pressure rising and the casinghead pressure falling. He then choked the well until the casinghead pressure ceased to decline, but not enough to kill the well. This prevented the escape of gas from the annular space, and reduced the well to steady flow, though at a low rate, due to the choke. The choke was then opened very gradually, care being taken not to allow the gas to escape from behind the tubing, until the well was at its former production rate on steady flow, the surging and heading with its pulling in of sand having been eliminated.

Fig. 2-



V. Wells With Insufficient Velocity in the Flow String

The final type of flowing well was the familiar one where the production of oil and gas had decreased to such an extent that the total volume of oil and gas was insufficient to give the necessary minimum velocity. Such wells could be brought back to steady flow by the introduction of extra gas or air, or by running a smaller size flow string as described in Section I of this paper. This type of well is too well known through gas lift literature to need further description.

VI. Conclusions

The writer would put forth the following conclusions on flowing wells, provided they are flowing with gas and not by hydrostatic pressure. Wells in such fields as the Seminole, where there is neither hydrostatic pressure or sufficient gas to lift the oil are also excluded.

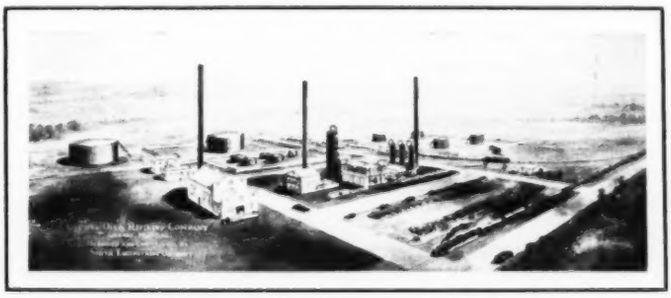
1. That flow velocity furnished a convenient and accurate index for estimating the flowing potentialities of a well.

2. That unless a certain minimum velocity, depending upon viscosity and other factors, is attained, a well will not flow even though it has sufficient gas available mechanically to lift the fluid.

Plans Announced for Refinery in Montana

THE Laurel Oil and Refining Company has announced plans for the construction of a million-dollar refinery to be located at Laurel, Montana.

The company, which was recently formed, is backed by a group of West Coast and Kansas business men, headed by Alfred J. Deischer of Winfield, Kansas; F. W. Camp and Roscoe Nelson, of Portland, Oregon. San Francisco interests are also associated with the new enterprise.



The plant will have an initial capacity of more than one thousand barrels of gasoline daily. It is to be erected upon a site of one hundred and three acres, which was recently purchased by the company. The site is particularly advantageous, being located adjacent to the City of Laurel, Montana, on the railroad branch and main highway. It is also adjacent to the Yellowstone River.

The design, construction and operation of the plant will be in the hands of the Smith Engineering Company of Kansas City, which has been awarded the contract for the erection of the first unit. The initial unit to be constructed at a cost of $1,000,000.00 is the first section of the ultimately large refinery which the Laurel Oil and Refining Company proposes to build.

The plant, when constructed, will represent a modern installation, being very compact and efficient and will comprise the following general units:

(1) A topping and reducing pipe still unit producing anti-knock gasoline and distillate and running the crude down to heavy residuum.

(2) This residuum will then be transferred hot to a modern continuous coking or asphalt plant, which will produce coke or asphalt as desired.

(3) The latest and most efficient process for the continuous treating of the gasoline produced will be installed.

(4) Necessary auxiliaries, such as an efficient steam generating plant, refinery transfer pump house, storage tanks, office, loading rack, etc., will be supplied.

The plant will be provided with an adequate fire fighting system, together with proper water mains and fire plugs.

The Laurel Oil and Refining Company plans to install a complete lubricating oil plant in the very near future.

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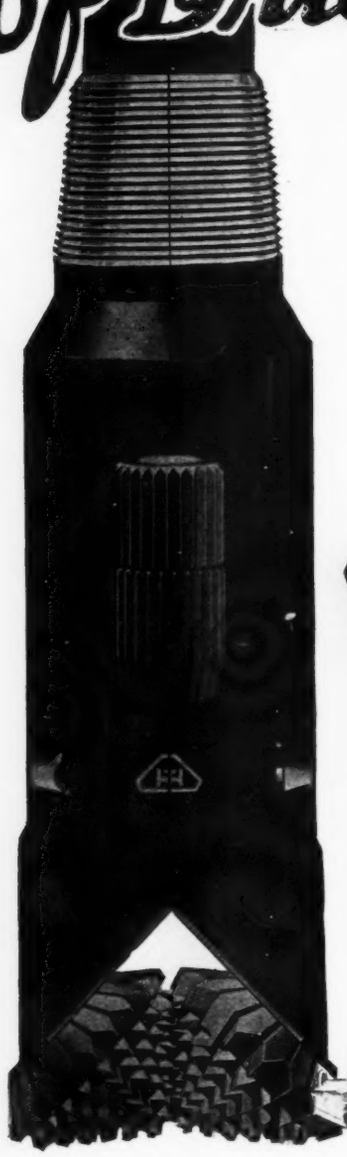

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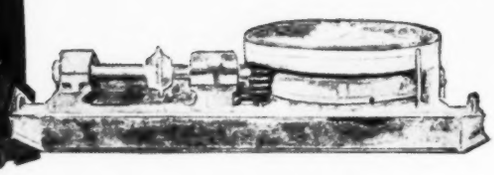

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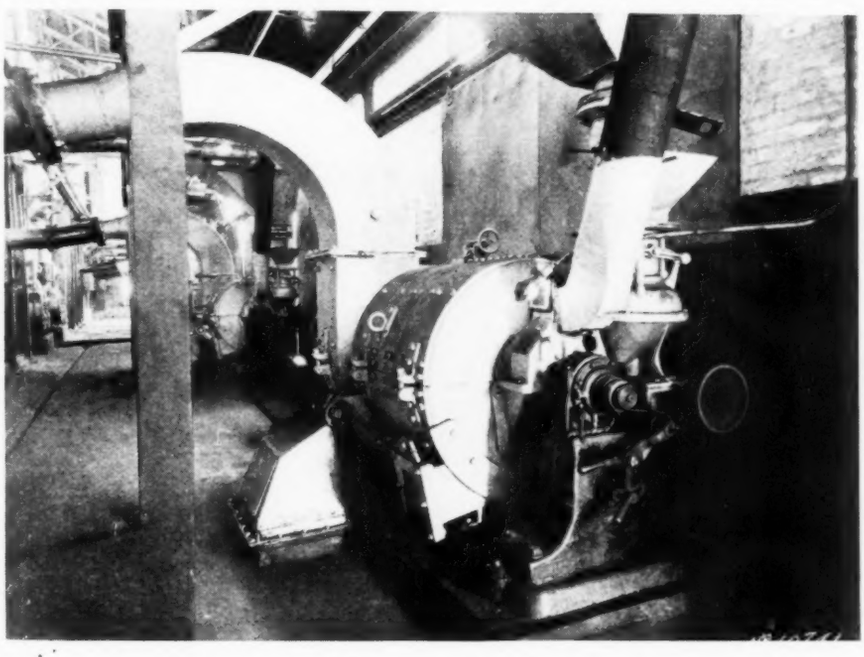
Trends in Use of

Oil Furnaces for Processing Oils

FRANK PRAEGER[1]

DURING the last five years the question of heat transfer in furnaces has become of increasing interest to that portion of the petroleum industry engaged in processing oils. This has been due in part to the enormous increase in the quantity of oils raised to high temperatures, and in part to the widespread adoption of cracking methods requiring high rates of heat transfer. In either case it has been found necessary to transfer great quantities of heat to oils, and questions of cost of equipment, area of ground covered, operating costs and maintenance costs of large installations have become important.

Accordingly, alert refiners have been investigating various types of furnaces with a view to finding one of reasonably low first cost, small ground area, simple operation and low fuel consumption (or high efficiency) that will transfer heat in quantities great enough for their needs, generally in quantities greater than those of previous installations.



Aero pulverizer firing pulverized petroleum coke. (Courtesy Foster-Wheeler Corp.)

The normal approach to the problem has been to look for some means of increasing the coefficient of heat transfer from the heating elements (hot flue gases, masonry, etc.) to the oil being processed. This coefficient is usually expressed as the number of heat units (B. T. U.) transferred per hour, per square foot of contact surface between the oil to be heated and the heating apparatus, per degree Fahrenheit Mean Temperature Difference. The Mean Temperature Difference, of course, is determined by the logarithmic formula, and for great differences in temperature is approximately equal to the difference, in degrees Fahrenheit, between the average temperature of the element of the furnace giving up heat and the average temperature of the oil being heated.

Heat is basically transferred either by contact between the warmer and cooler bodies (known as the transfer of heat by conduction) or by the propagation of radiant heat rays from the warmer body to the cooler body (known as the transfer of heat by radiation). The transfer of heat by convection is derived from the transfer of heat by conduction. The term refers to the transfer of heat between a solid and a fluid (either a liquid or a gas), when the fluid is in such motion that more of its molecules come into contact with the surface of the solid than would be the case if the solid and the fluid did not change their relative positions. It has been found that in every furnace there is at least some transfer of heat by each of the three methods.

When heat is transferred either by conduction between a solid and a fluid or by convection, it has been found that there is always a stationary film of the fluid next to the solid. This film has a temperature between that of the solid and that of the remainder of the fluid, and acts as an insulating agent, decreasing the rate of heat transfer. Thus, in an oil heating furnace of the convection type, we find a hot body of flue gases around the container of the oil, a thin film of much cooler flue gas in immediate contact with the container, the container itself at a somewhat lower temperature than that of the film of flue gas, a film of oil inside the container and in immediate contact with it, and finally the body of the oil inside the container at a lower temperature than that of the container or the stationary film of oil in contact with it. There are, then, two films of fluid which tend to decrease the rate of heat transfer. When the fluids are in motion these films decrease in thickness (molecules being torn away by the motion of the main body of the fluids) and the greater the velocity of the fluids the thinner the films. However, the films never entirely disappear, and always effect some decrease in the rate of heat transfer.

The substitution of pipe stills for the older type of shell stills decreased this difficulty and improved the coefficient of heat transfer by decreasing the thicknesses of the stationary films of oil inside the tubes and of flue gas outside of the tubes (due to the increased velocities of both oil and gas).

In the older types of furnaces the majority of heat was transferred by convection. The coefficient of heat thus transferred varied with the weight of flue gases coming into contact with the tubes of the still, and in the most efficient types of furnaces followed quite closely the Carrier equation: $^{b}G = \frac{22.3W}{1.42 + W}$

[1] Alcorn Combustion Company.

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In this equation, ^{h}G = coefficient of heat transfer, B. T. U. per square foot per hour per degree Fahrenheit Mean Temperature Difference; w = mass velocity of the gases = pounds of flue gases flowing through the tubes per second per square foot of clear area in the plane through the center lines of the tubes of any row. The equation was designed for the case of hot gases flowing at right angles through a close bank of tubes.

Certain pipe still furnaces of the convection type are equipped with powerful hot air fans that pick up the majority of the flue gases en route to the stack and drive them through the tube sections with the fresh products of combustion. This recirculation of flue gas increases the mass velocity of the gases passing through the tubes and increases greatly the rate of heat transfer. It can be used quite successfully with most varieties of convection furnaces.

In recent years there has been an increase in furnaces utilizing the transfer of heat by radiation. This type of heat transfer has numerous advantages.

Rates of heat transfer are very high, as they tend to follow the Stefan-Boltzmann formula, in which the heat transfer per hour equals

$$pc\,A \quad \left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right]$$

"A" is the area of the surface exposed to radiation, in square feet; "p" and "c" are constants based on the radiating and heat absorbing qualities of the materials used and the furnace conditions generally; "T_1" is the temperature in degrees Fahr., absolute, of the radiating body or substance; "T_2" is the temperature in degrees Fahr., absolute, of the body being heated. Obviously, as the difference between "T_1" and "T_2" increases, the amount of heat transferred per hour increases disproportionately.

In addition, the presence of the stationary film of flue gas in contact with the surface of the oil container does not hinder the transfer of heat by radiation. Not only is the full transfer of heat unimpeded, but also it is not necessary to have excessively hot flue gases in contact with the tubes. This effects a considerable saving in maintenance of tube or shell stills.

Furthermore, since the transfer of heat by radiation is dependent on the difference in the temperatures of the radiating and heat-absorbing bodies, a great mass of flue gases is not needed, and the percentage of excess air is reduced. This makes for less possibility of oxidation of metal in the furnace, and tends to reduce stack losses.

The transfer of heat by radiation is usually considered as of two types. In one, heat is radiated from hot bodies (masonry, metals, carborundum, etc.), in the furnace to the oil container. In this type of heat transfer the Stefan-Boltzmann formula applies directly. In the other type, heat is radiated from the flames, particles, and even hot molecules, of the flue gases. This type of radiation cannot be easily calculated by formula, as it is dependent on many considerations. Considerable work has been done in preparing charts and graphs showing the rate of transfer of this type of heat under various conditions. The transfer of heat by radiation from the hot gases is always greatly increased by decreasing the percentage of excess air. Several types of furnaces are based on the transfer of heat primarily by one or the other of these two types of radiation, though both types are present to some extent, at least, in any furnace.

During the last few years various improved types of convection and radiant heat furnaces have been installed in many places, so that comparisons are possible. It has been definitely shown that the old type of shell still does not efficiently transfer large amounts of heat. Similarly, the simple pipe still cannot handle high rates of heat transfer in a furnace of reasonable size. Certain furnaces primarily of a convection type use flue gas recirculation very successfully in attaining increased rates of heat transfer. They have, however, the additional first cost, increased operating expense and considerable maintenance charges of the recirculating equipment. The latter is an important item, as it is difficult, if not actually impossible, to find a fan that will not deteriorate rapidly under the strain of recirculating large quantities of flue gas at temperatures between 900 degrees Fahr. and 1100 degrees Fahr.

Furnaces have been built to utilize in varying degrees the transfer of heat by radiation. Being a recent development, such furnaces have not always been operated to full advantage, but, even so, it has been apparent that high coefficients of heat transfer have been safely obtained. These coefficients are often as high as 25 to 30 B. T. U. per hour per square foot per degree Fahrenheit Mean Temperature Difference in a radiant section, as contrasted with a similar figure of not over 10 obtained in sections of a purely convection type. At the same time, when properly designed and operated, radiant heat furnaces have shown a regular temperature rise and smooth temperature gradient through the tubes.

It is worth noting that the best results have been obtained in radiant heat furnaces where there have been both radiant and convection sections, the two types of sections being separate and distinct. In such a case the tendency to coke formation is decreased and tube longevity is increased.

During the various stages of the development of furnaces there has been a constant question as to the value of air preheaters. As a rule, designers and builders of furnaces have realized their value, but many refinery executives have objected to them on the score of maintenance and cleaning costs.

The advantages in the use of air preheaters are many. They conserve fuel (although this is not an important point in many refineries where it is necessary under present refinery conditions to dispose of undesirable fuel oils and gases). They reduce stack temperatures, thus prolonging the life and decreasing the maintenance costs of the stacks. By furnishing hot air they increase the speed of combustion and cause more efficient firing conditions and more even distribution of heat transfer. Ordinarily these advantages outweigh the disadvantages of cleaning and repairing the air preheaters, so that furnace designers usually require the presence of preheaters.

In general, it has been found that the old type of shell still, whether in a convection or radiant heat type of furnace, has been inferior as a heat transfer agent to a pipe still. Similarly, a pipe still in a simple convection type of furnace has been inferior to one in a convection type of furnace in which flue gas is recirculated, while the highest coefficients of heat transfer have been obtained in pipe stills in radiant heat furnaces.

From the point of view of plant efficiency, the same order of value appears to obtain. In a modern type of radiant heat furnace the heat input to the oil is at least as large, compared to the heat produced by the fuel, as is the case in older types. However, this comparison is hardly fair to the more modern furnaces, as experience has shown that where an older type is designed to meet modern demands in heat input the stack losses and losses due to radiation are increased disproportionately. When placed in similar service this has resulted in showing that the modern radiant type is more efficient than the convection furnace.

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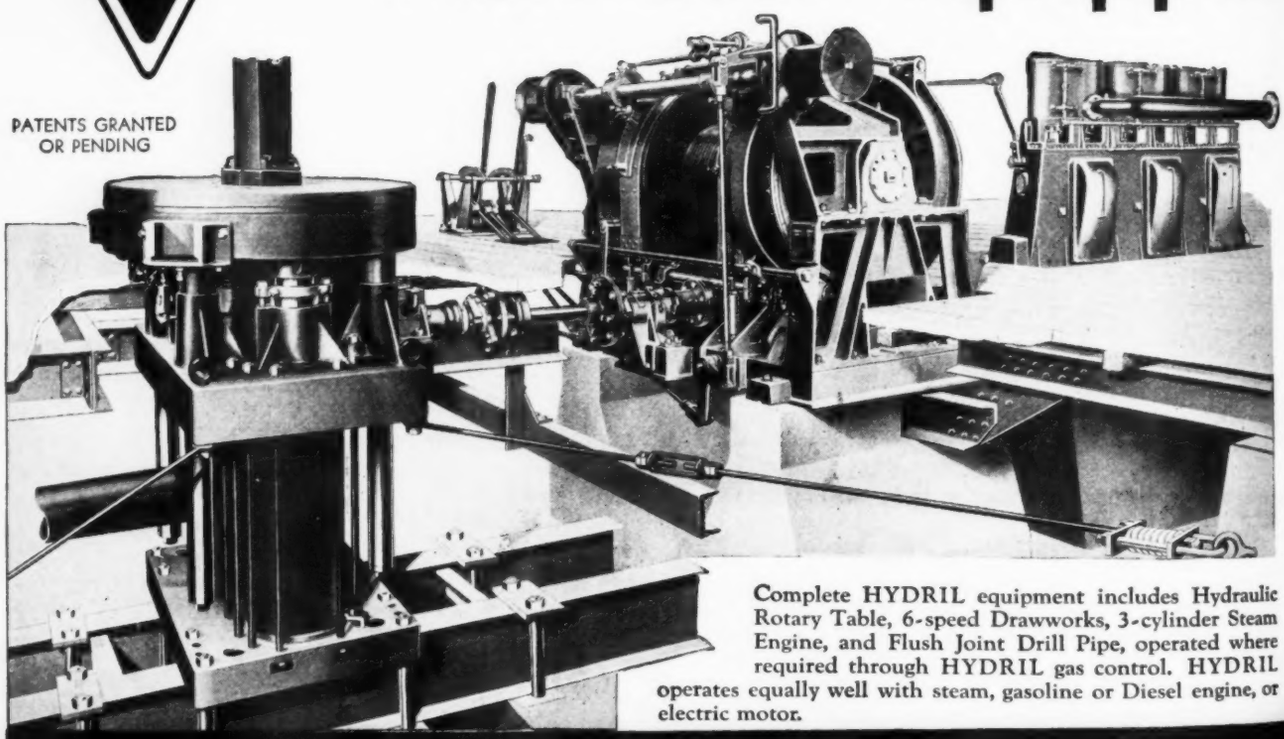

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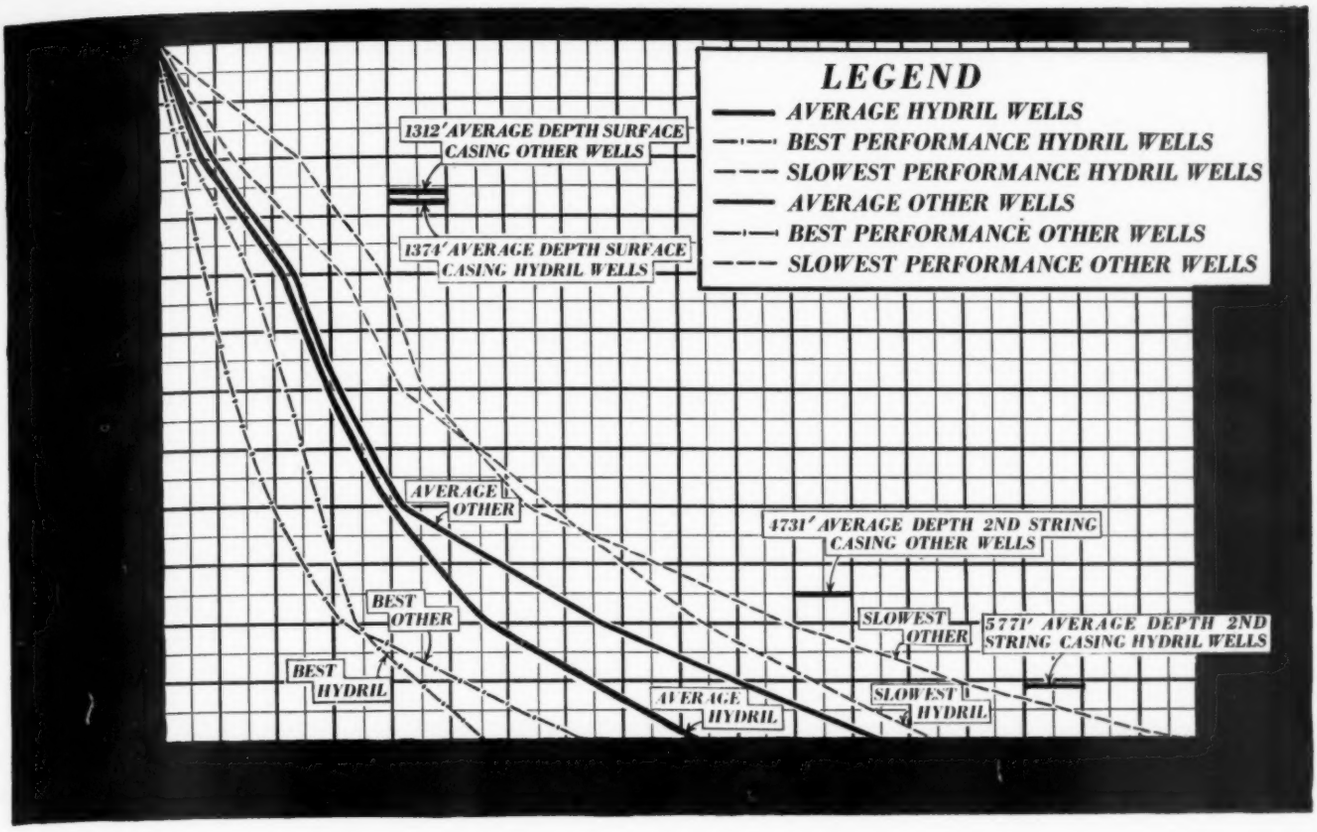

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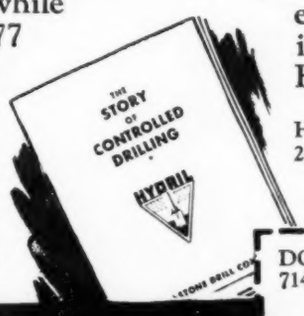

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Metallurgy of Modern Drilling Equipment

By H. W. FLETCHER**

ABSTRACT

Modern deep drilling has forced a notable improvement in the materials used on the rotary rig.

Alloy steels now in general use have overcome many of the difficulties experienced by early operators.

Heat treatment enables the manufacturer to modify physical properties to meet specific service requirements.

Rigid control of material and manufacturing processes is essential to maintain the required uniformity of properties.

EARLY oil wells were shallow, and the loads on equipment were correspondingly light. Fishing was less difficult and wells were much less costly, so that skidding over was often the obvious solution to a too complicated fishing job. Such service conditions called for an outfit low in first cost, light for maximum portability, and sufficiently simple that it could be readily set up and repaired. A description of the materials of one of these early rigs would include cold drawn shafting, malleable chain, cast iron sprockets and sheaves, cast iron rotaries, and low carbon lap weld drill pipe and couplings, used without tool joints. Drilling valves when used were cast iron or semi-steel.

As drilling extended to deeper territory, it became evident that the pipe coupling would not support the increased punishment; and the introduction and development of the rotary tool joint followed.

While these early tool joints were a great improvement over the pipe coupling for drilling, they were made of relatively soft material; and it soon became evident that they must be further protected against galling. A number of manufacturers began heat treating the pins only, using a simple quench and draw, or in some cases cyaniding the pin threads.

Again improvement was noticeable, and again service requirements increased in severity to a point where this solution of the problem proved inadequate. Not only was there still a remnant of the galling difficulty so common before tool joints were used, but other difficulties arose: tool joints split longitudinally and pulled off the pipe, or the pins "jumped" and parted the string. Moreover, tool joints were relatively expensive, and wear on outside diameter became a serious problem. The introduction of alloy steel and full heat treatment of both box and pin provided a fairly satisfactory solution.

While this development was under way, other parts of the rig were passing through a similar cycle; and we find on the modern rig of today seamless drill pipe—in many cases heat treated—alloy steel rotary chain, sprockets, and sheaves, steel drilling valves and casing heads, and all steel rotaries.

On every hand, manufacturers are proclaiming the excellence of their product because "it is alloy steel" and because "it is heat treated." That real benefits must be realized is apparent from the ever increasing use of these more expensive materials and processes, but what these benefits may be and how they are best secured in a specific case are matters for consideration.

Four quantities are customarily used in describing the physical properties of a metal. They are ultimate strength, elastic strength, ductility, and reduction of area. Each of these quantities is evaluated by testing to destruction a test piece of the material in question, of specified diameter and under specified conditions of loading. A change in the dimensions of the test piece or in the conditions of loading will alter the numerical values secured from the test, but at least the figures are comparable between various standard test specimens. The use of these quantities as a measure of the relative suitability of various materials for a given practical application is justified, provided due consideration be given to the modifying influence of product, shape and manner of loading in actual service.

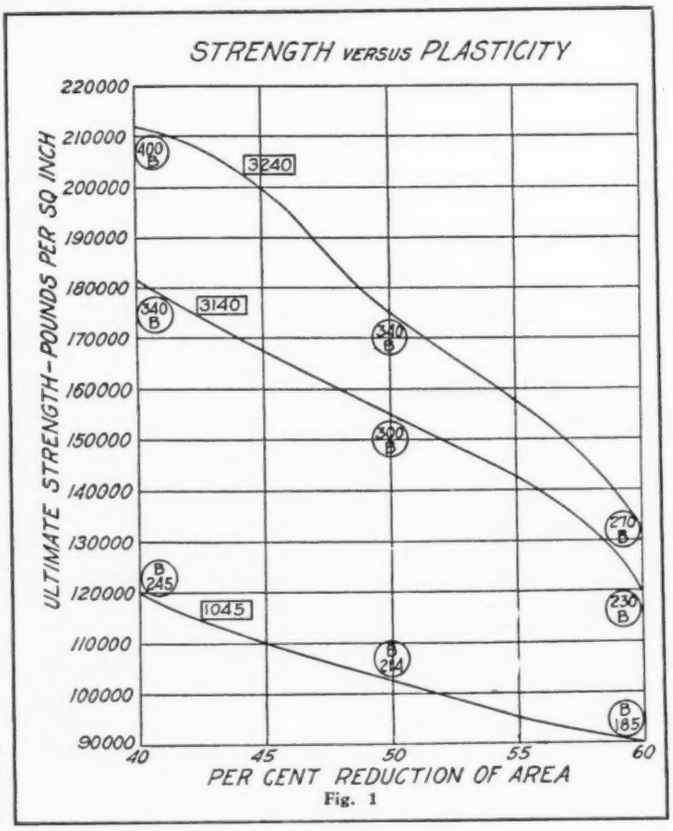

Fig. 1

The ultimate and elastic strengths are a measure of the ability of the metal to carry load, while the elongation and reduction of area indicate the extent to which it can deform under load without fracture. This latter property is quite as important as the former, since design considerations will but rarely permit the complete avoidance of undesirable stress concentration arising from the notch effect of threads, shoulders, and keyways. If the metal is plastic, it will yield at those points where stress is excessive, and so redistribute the load over a larger area of metal. If it is not plastic, a small crack may develop, which in turn will vastly increase the local stress; the crack will extend; the process will repeat, and complete failure will result.

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* Paper Delivered at Tenth Annual Meeting, American Petroleum Institute, Chicago, Ill., December 8, 1929.

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Fortunately heat treatment furnishes a means for adjusting the relative values of strength and plasticity, and the introduction of certain alloys affords still further control of these properties.

With the exception of the carburizing and nitriding processes, heat treatment properly carried out does not alter the chemical composition of steel. It does, however, affect the physical distribution of the elements in the steel. By simply heating to the proper temperature and cooling rapidly, the strength of the material can be raised to a surprising degree, the effect being much more pronounced with the so-called alloy steels than is the case with plain carbon steels. Unfortunately, the plastic properties are simultaneously reduced; and if care is not used, stress concentration may entirely offset the gain in strength. Furthermore, the outside of the steel must be cooled first, and the outer layers consequently shrink before the inner portions cool, setting up bursting stresses due simply to volume changes. However, if the process is skillfully handled, actual cracking of the metal during this sudden cooling can be avoided, and the metal can then be reheated to a lower temperature, thus relieving these stresses. Therefore, heat treatment can be used to adjust the relation of strength to plasticity in accordance with estimated requirements of the job.

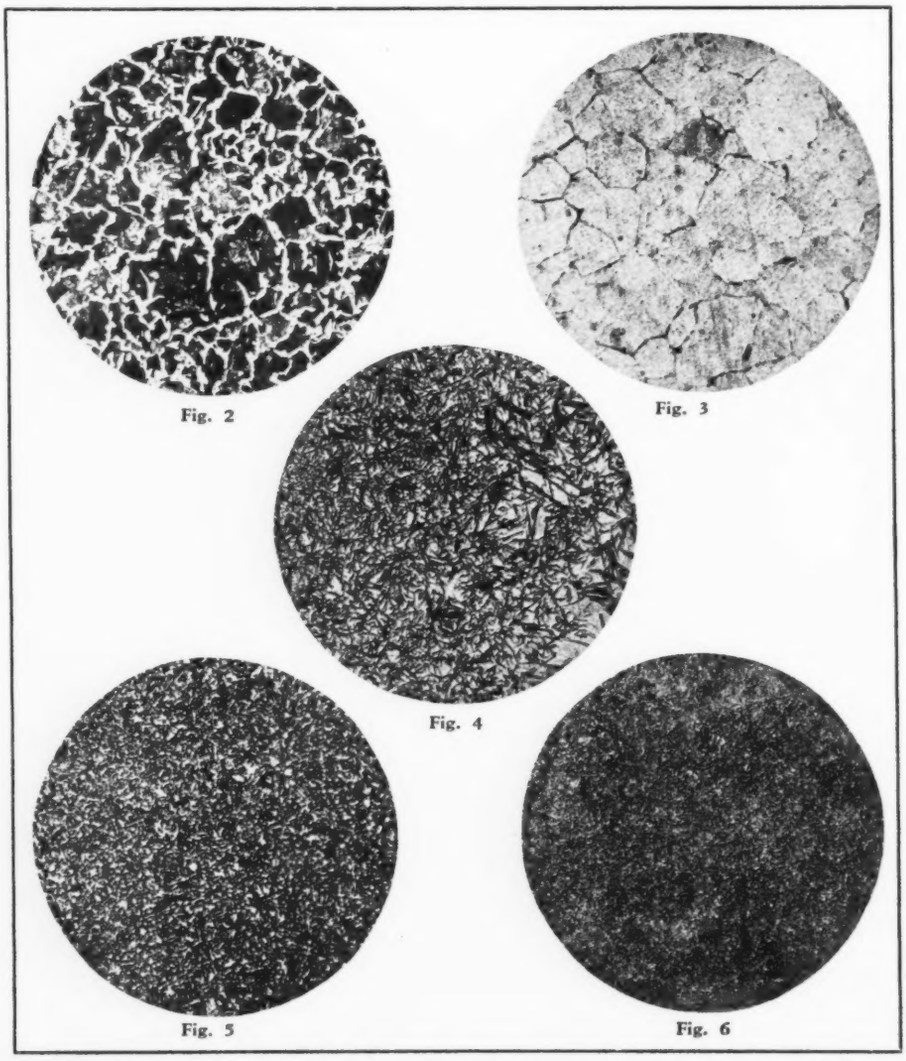

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

The tool joint can be considered as an example for the application of these ideas to rotary equipment. The most common causes of failure in early tool joints were galling, stripping of threads, wear from abrasion, tension failure of the pin, and splitting of the pipe ends. It can be concluded that if a harder and tougher material is used, galling and abrasion will be reduced; while failures in the pins and pipe ends can be controlled by using a stronger material. Immediately, however, it will be perceived that the fundamental properties do not describe hardness and toughness directly, and further consideration shows that a satisfactory general definition is most difficult to form. However, it is safe to conclude from analogy that if the strength be raised, hardness and perhaps toughness will be increased somewhat, and then remains a decision as to how much plasticity can be sacrificed safely. Here a question of judgment is involved, which can only be solved on the basis of previous experience and justified by service performance. Suppose, however, that a heat treated alloy steel, with an appreciable higher strength and a plasticity little—if any—below that of the material formerly used, can be found. It is reasonably certain that improvement will result if uniformity of practice can be satisfactorily maintained, for it should be kept in mind that careless handling of sensitive steel may easily result in more failures than would follow the use of a lower grade stock, unheat-treated.

Evidently, it is necessary to control the temperatures of heating and quenching, the rate of heating and—most important of all—to have some method of inspection that will cull out defective pieces before they leave the plant. In this case, inspection by Brinell impression is the most satisfactory test now available.

Brinell values and strength are rather closely correlated for a given steel, so an upper and lower Brinell limit can be set and manufacture can be started—preferably on a rather small scale at first. Now field performance must be watched closely, and the cause of failures must be analyzed; the upper Brinell limit can then be reduced if the material seems to be too hard (not sufficiently plastic), and the lower Brinell limit can be raised if the material seems too soft as evidenced by excessive galling and wear. As data accumulates year after year, field failures will be markedly reduced and about equally divided as to cause (hardness or softness), indicating that the best possible range of treatment for that particular product and material has been developed.

This broadly is the general method of attack on all problems of this nature: first a tabulation of types of failure; then a consideration of the probable influence of a change in the fundamental physical properties; and, finally, controlled manufacture accommodated to field experience.

Many alloy combinations are on the market, and the problem of selecting the best for a given purpose is by no means a simple one. However, the steel manufacturer is often able, through past experience with related service problems, to recommend two or three steels that are fairly certain to give satisfaction, which narrows down the field. As a measure of the relation between strength and plasticity, Fig. 1 shows ultimate tensile strength plotted against per cent reduction of area for various heat treatments. Three steels are illus-

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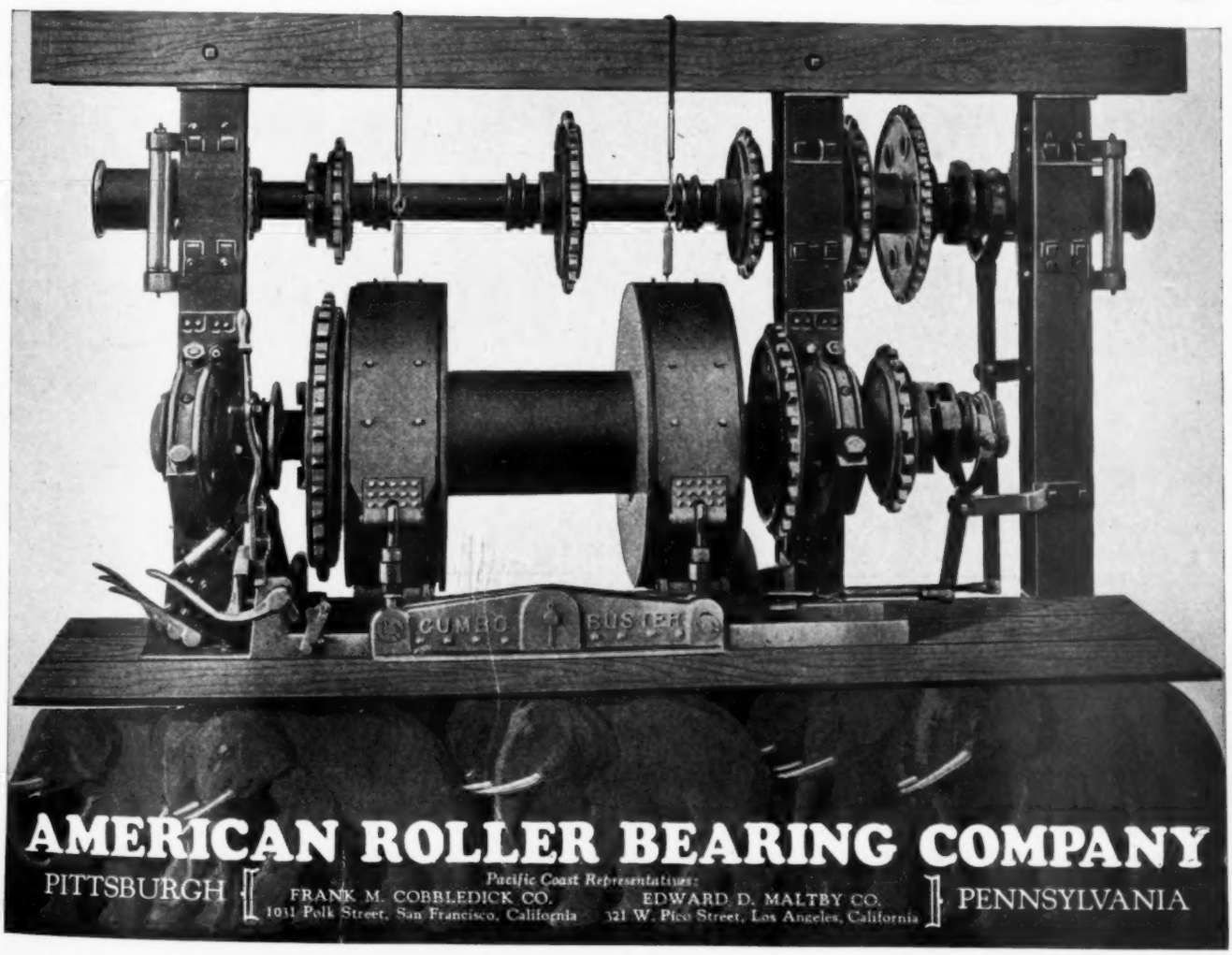

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trated: a simple carbon steel containing 0.45 per cent carbon; a chrome nickel containing 1.25 per cent nickel and 0.6 per cent chromium; and another chrome nickel containing 1.75 per cent nickel and 1 per cent chromium, both the chrome nickel steels bearing 0.4 per cent carbon.

If it be decided that a reduction of area of 50 per cent will represent sufficient plasticity for the purpose at hand, and if an ultimate strength of 100,000 lb. per sq. in. is great enough, then inspection of the graph shows that all three of the steels meet these requirements; and the selection must then be based on relative cost, commercial availability, ease of machining, and the question of how much margin the assumed requirements provide over the actual service conditions to be met. It must be remembered that corrosion, fatigue, abrasive wear, roughnecks with sledge hammers, and other detrimental agencies will be encountered in the field. The writer recalls one instance when a new string of chrome nickel tool joints on a foreign wild cat was cyanided in an open forge fire, while the crew waited for cement to set. Had these tools been simple carbon, they might not have been greatly harmed; but, as it was, they were ruined. This is, of course, an extreme case, and would have little weight in determining the selection of material; but other examples may be cited that do apply. For instance, early alloy joints were made quite hard to reduce abrasive wear, while at the same time plasticity was not reduced below that of the carbon joints then in use. A most satisfactory reduction in wear resulted, but tong difficulties were so excessive that the operators undoubtedly suffered a net loss, even though their joints lasted longer.

Fig. 7

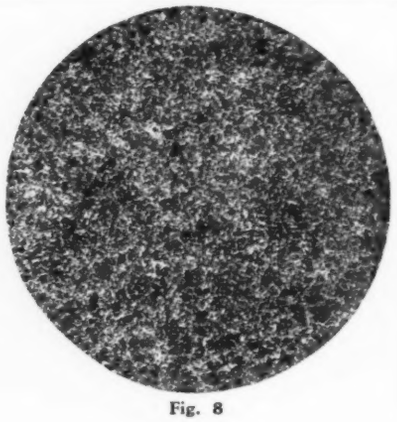

Fig. 8

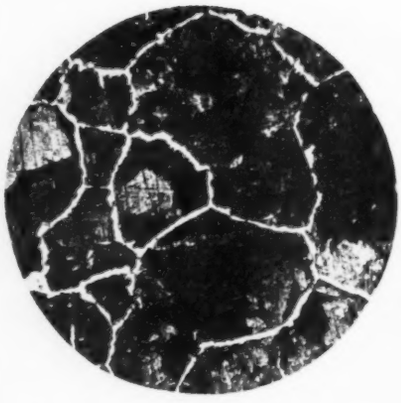

Fig. 9

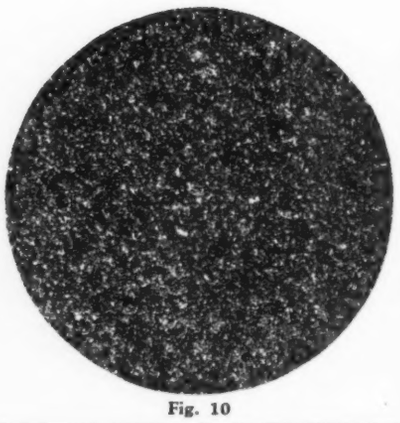

Fig. 10

Suppose now that experience with the straight carbon steel 1045 has been unsatisfactory, i. e., if the heat treatment produces sufficient plasticity, the strength is too low and vice versa: the question arises as to whether 3140 or 3240 shall be used. About 10 per cent greater strength can be obtained by using 3240 instead of 3140. On the other hand, the former is more expensive, more subject to internal defects in course of manufacture, more delicate to heat treat, etc. It is entirely possible that failures might be more frequent using 3240 than would be the case with 3140. On the other hand, if service loads should increase to a point where on the average the 3140 is working very close to its limit, a 10 per cent increase in strength secured by changing to 3240 might almost eliminate failures. It is a hard question, and must inevitably be solved in relation to the special condition of any single case.

Much has been said about using heat treated alloys to increase strength, and the question might well be raised: "why not make the parts bigger?" Sometimes that can be done. A drawworks shaft, for instance, can be made 60 per cent stronger, and at the same time stiffer, if it is increased from 6 in. diameter to 7 in. diameter. It will be 36 per cent heavier, but then it is pretty heavy anyhow. On the other hand, as can be readily seen from Fig. 1, it can be made 60 per cent stronger, but no stiffer, by substituting heat treated alloy steel; it will be no heavier, but it will cost at least twice as much. Obviously, an increase in diameter is the logical way to secure greater strength in this case, provided the greater weight does not too greatly affect the matter of portability.

On the other hand, rotary chain is subject to impact as the rollers meet and leave the sprocket teeth. If the size, and hence the weight, of the chain parts is increased to secure greater strength, the force of these impacts is increased; and it is entirely possible to reach a point where further increase of size will result in an increase in failures. Here is an excellent opportunity to improve matters by using heat treated alloy steels. As the strength of the material is increased the weight required to carry a given static load is reduced and, hence, the dynamic loads are less. Rotary chain manufacturers have universally availed themselves of this opportunity, securing at the same time the advantage of greatly increased resistance to wear.

A third class of product is restricted in dimension by service requirements, e. g., bits and tool joints obviously must be smaller than the holes in which they are used. There is no alternative when greater strength is required. Heat treated alloy steels will provide the additional strength in the same space, the only question being what alloy and how to heat treat it.

Heat treatment consists in slowly raising the temperature of the piece until, at the so-called critical temperature, the grain structure—normally pearlitic at low temperatures—is converted to a form called austenite. Entirely new crystals

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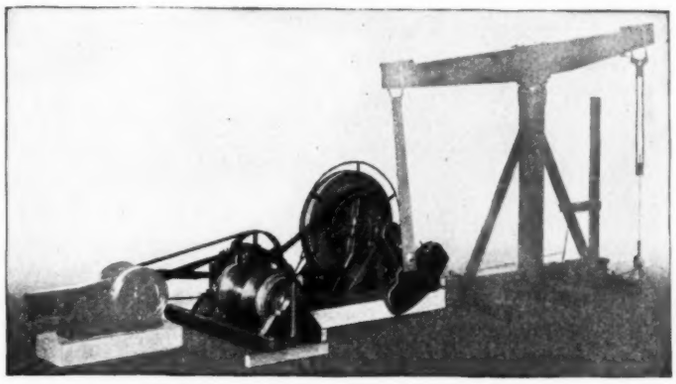

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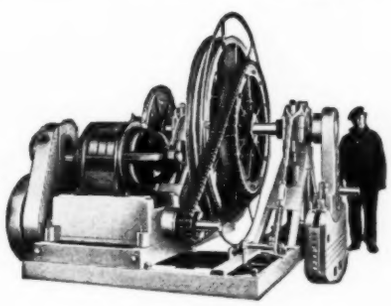

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are formed, small at first but growing larger as the temperature continues to increase. If the steel is cooled slowly, the process will reverse, and the austenite will be converted back into pearlite, the physical properties remaining practically unaltered. If, however, the steel is cooled suddenly by plunging it into relatively cold oil or water, this transformation can be suppressed to a degree depending on the chemical composition of the specimen. In this condition, the material exhibits maximum strength and hardness, and minimum plasticity; and is generally unsuitable for service. The microstructure resulting will depend on the speed of cooling and on the rate at which the transformation takes place, i. e., it may not be possible to cool the specimen quickly enough to prevent a certain degree of transformation; and, hence, the quenched structure, instead of being austenite, may be one of the intermediate structures: martensite, troostite, or even sorbite. Figs. 2 to 6, inclusive, show representative micro-photographs of these five crystal structures, in the order in which they occur in heat treatment, starting with a pearlitic structure, converted to austenite on heating above the transformation point, changing back through martensite to troostite during quenching, and altered to sorbite by reheating commonly called "drawing."

Sprockets and sheaves of 14 per cent manganese steel are martensitic in structure as cast, since these high percentages of manganese slow up the transformation to a very high degree; and even very slow cooling in sand molds is in effect a quench. Martensite is very hard, but also very brittle, and hence unsuited for this type of product; so the castings are reheated to a point where the martensite changes to austenite, and are then quenched to prevent the austenite from changing back. The austenite is not so hard, but is much tougher and more plastic than the martensite, exhibiting great shock resistance and resistance to abrasion. Nickel and chromium added in large amounts will also suppress the transformation to a point where an austenitic structure is readily produced, and are useful because of the exceptional resistance to oxidation at high temperature and to corrosion exhibited by these alloys.

As the amount of alloy used is reduced, the rate of transformation increases; the austenitic structure can no longer be retained on quenching, resulting instead in martensite or a mixture of martensite and troostite. These structures are adjusted to meet requirements by reheating to the proper temperature, the operation being called "drawing" or "tempering."

Grain size can also be controlled to a considerable extent in heat treating. (See Figs. 7, 8, 9 and 10.) When the austenite crystals first form on heating, they are very small; and increase in size as the temperature increases above the transformation point and with time. The size of the grains in the quenched structure depends largely on the size of the austenite grains from which they were formed. As experience has shown that, in general, the finer grained steels have the best physical properties, it is evidently necessary to keep the size of the austenite grain as small as possible, always bearing in mind the fact that heating must be carried a little above the transformation temperature to be sure the transformation is complete, and that the piece must be held at temperature long enough to reach a uniform temperature throughout. Variations in weight, shape, and alloy composition of product will control the procedure.

The foregoing discussion has dealt with the composition and heat treatment of products where uniform properties are desired throughout the specimen. There are important cases, however, where combinational properties are desired. For example, the cutting edge of a fish tail bit must be very hard to take a keen edge and resist abrasion. Obviously, the micro-structure must be principally martensite which, because of its brittleness, is entirely unsuitable for the shank and blade of the bit. The entire bit is, therefore, annealed producing a pearlitic structure; the cutting edge alone is reheated above the critical point; then quenched, retaining the required martensite structure, and perhaps drawing it back at a temperature of 400 or 500 degrees to relieve the quenching strains. Of late the problem has been attacked from another angle: by welding to the cutting edges a very hard alloy which is practically unaffected by heat treatment. After this alloy has been applied, the bit as a whole can be normalized or annealed without affecting the cutting edge.

Still a different type of problem presents itself in the manufacture of rock bit rollers and cones. Here it is desirable that the entire surface of the parts be very hard, but the interior should preferably be soft to prevent the comparatively thin sections from cracking through. The problem is met by making the parts of a very low carbon steel, and then heating them for many hours in contact with some form of carbon. The carbon is absorbed by the steel, and a surface layer may be built up containing over 1 per cent carbon. When this high carbon skin has become thick enough, the parts are cooled, reheated to a temperature above the critical for the low carbon core, and quenched in oil. This refines the core, but the case has been somewhat overheated and, hence, the crystals are rather large and the fracture is brittle. This condition is corrected by reheating to a temperature just over the critical of the case, but below that of the core; and the parts are again quenched. The process is completed by drawing for an hour or so at about 350 degrees to relieve quenching stresses.

The foregoing is a rather sketchy summary of the history of the introduction of heat treated alloy steel into rotary drilling equipment, and a still more superficial discussion of the manner in which the various problems encountered are attacked and the way in which heat treatment provides some degree of control over the properties of available materials.

In the past, improved equipment has been produced as required by the increasing demands of deeper drilling. Present equipment will probably prove unsuitable in the years to come, but it may be confidently anticipated that an adequate solution will be found in which the metallurgical aspect will play an increasingly important part.

LAYING A LINE AT OKLAHOMA CITY

The Oklahoma City field, which holds exceptional interest at present, is the scene of much activity. Pictured above is a line laid by the Shell Petroleum Corporation in that field.

Equipment Correlation for Steam Rotary Drilling[1]

J. R. GIGNOUX* and R. A. MARCH†

THE correlation of drilling equipment is an important matter to oil operators because of the need for obtaining a proper balance between the numerous items included in the rotary rigs. Deeper drilling, with its required heavier strings of drill pipe and casing, is resulting in increased loads on and duty of all parts of the equipment to a point where their proper selection and relation cannot longer be ignored.

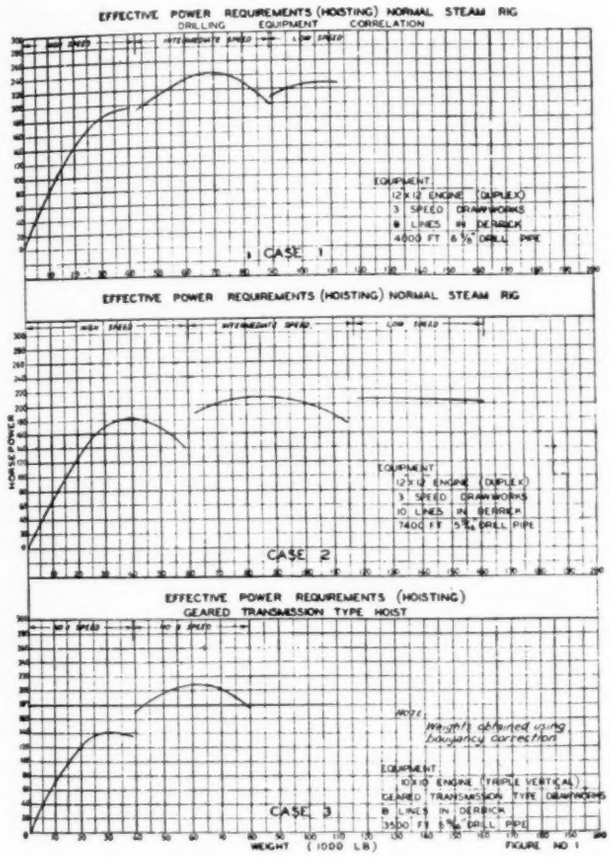

FIGURE NO 1

In analyzing the situation comparisons between the present equipment and the loads it is successfully handling must be made. These comparisons will serve as a guide to the changes which may be required in the equipment when greater loads are imposed. The comparisons in this paper are of necessity based on the normal drilling operations as now carried on in California in drilling to depths of from 7,500 to 8,000 feet.

Equipment in drilling rigs may be segregated into three major divisions according to its particular use, as, for example, hoisting, circulation of drilling fluids, and drilling. The hoisting equipment includes the rotary engine, the hoist or drawworks with its mechanism for various speeds, the wire line with its related gear, and other items used in handling drill pipe and setting casing. The pumping equipment covers the steam pumps used in the circulation of mud fluids, while the actual drilling equipment includes items used in the rotation of the drill pipe and bits.

Loads on Equipment and Power Requirements

Loads Resulting from Casing and Drill Pipe:

Present casing practices and possible future advancements serve as a guide to the loads that are now or may be imposed on drilling equipment. Table I gives the data on several sizes of casing that have been developed recently or are contemplated by manufacturers to meet deeper drilling conditions, and the setting depths are according to the specifications furnished to the trade. If strings of casing are set to the limits proposed by the tubular goods manufacturers, the dead loads to be hoisted would be as shown in columns 4 and 6 of the table. However, many of the extreme weights as listed are not likely to be used, or their use will probably be so far in the future that they are not a matter for present consideration.

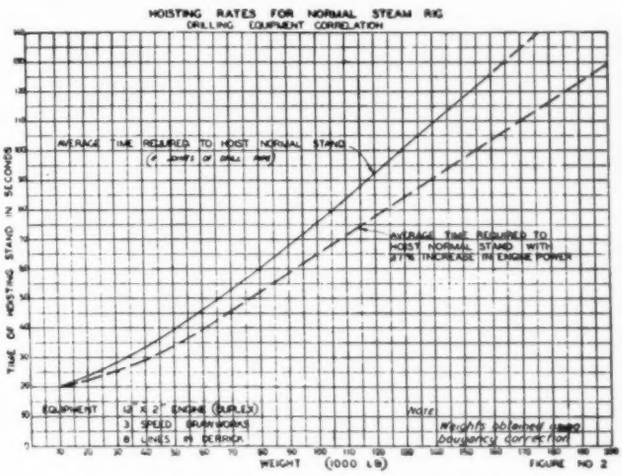
HOISTING RATES FOR NORMAL STEAM RIG
DRILLING EQUIPMENT CORRELATION
AVERAGE TIME REQUIRED TO HOIST NORMAL STAND
AVERAGE TIME REQUIRED TO HOIST NORMAL STAND WITH 27½% INCREASE IN ENGINE POWER
TIME OF HOISTING STAND IN SECONDS
WEIGHT (1000 LB)

FIGURE NO 2

TABLE I

THEORETICAL SETTING DEPTHS AND WEIGHTS OF STRINGS OF HIGH-TENSILE CASING

Size O. D. (in.)	Weight (lb. per ft.)	9500 lb. per sq. in ultimate: *Max. setting depth (ft.)	9500 lb. per sq. in ultimate: Max. wt. (tons)	110000 lb. per sq. in ultimate: *Max. setting depth (ft.)	110000 lb. per sq. in ultimate: Max. wt. (tons)
13⅜	61.0 to 83.5	8000	334	9200	385
11¾	60.0	7500	225	.....	.....
10¾	55.5	8100	225	.....	.....
10	48.0 to 55.5	7600	211	8657	330
9⅝	43.8 to 57.4	8000	230	9100	260
9	46.5 to 54.0	8000	216	.....	.....
8⅝	36.5 to 44.5	8500	189	.....	.....
7	30.00	7600	114	8700	130
6⅝	26.0 to 29.0	8300	120	9500	138
5¾	22.5	7900	89	9100	103
4¾	16.0	8600	69	9900	80

Table II lists the heaviest strings of casing set to date and for comparison also shows future strings with their weights, which will probably be set within a short time.

* Chief Field Engineer, Shell Oil Company, 414 Higgins Building, Los Angeles, California.
† Assistant Engineer, Shell Oil Company, 414 Higgins Building, Los Angeles, California.

[1] Presented before the annual meeting of the A. P. I., December, 1929.

* Safety Factor 2½ on pullout strength of joint.

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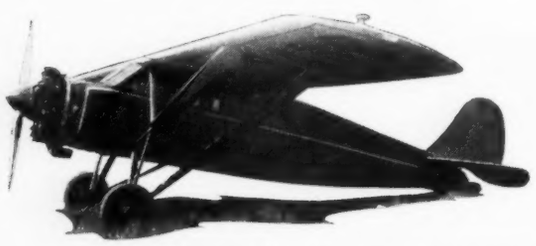

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TABLE II

PROBABLE LENGTHS AND WEIGHTS OF FUTURE STRINGS OF CASING COMPARED TO THE HEAVIEST STRINGS SET TO DATE

Size O. D. (in.)	Heavy Strings set to date Length (ft.)	Weight (tons)	Probable future strings Length (ft.)	Weight (tons)	Increase in Weights (tons)
13⅜	5425	195	6000	216	21
13⅜	5080	212	6000	250	38
11¾	5563	167	6500	195	18
9⅝	6463	175	7500	203	28
8⅝	7875	142	8500	190	38
7	7984	120	8700*	135	15
6⅝	7700	100	9000*	130	30
5¾	9144	107	9500*	112	5
4¾	8065	65	10000*	80	15

* The lengths of all strings of casing not marked are based on the pullout strength in Grade D material with a safety factor of 2½ or better. The lengths marked (*) either require a safety factor under 2½ for pullout using Grade D material or Grade E material may be used with a higher safety factor.

It will be noted that the heaviest string of casing now contemplated will weigh 250 tons, which is 38 tons heavier than the heaviest string set to date. It should be explained that the expected future casing strings have been determined on the basis of pullout strength only and numerous other factors enter into the consideration, such as formations encountered, water shutoffs, collapsing strength, hole size, and other conditions varying with locality. However, pullout strength determines the maximum casing loads to be expected on the drilling equipment in the near future unless casing practices are developed which are not foreseen at this moment.

As drill pipe must operate through casing, there is a relationship between the size and length of drill pipe strings that will be used and the depth at which the various sizes of casings are set. Table III lists the probable lengths and sizes of drill pipe strings which may be expected if the theoretical casing strings shown in Table II are eventually used. The sizes of drill pipe shown for use in the various sizes of hole are based on the practices of several California operators, the majority of whom follow about the same system.

TABLE III

PROBABLE LENGTHS AND WEIGHTS OF FUTURE STRINGS OF DRILL PIPE COMPARED TO THOSE OF PRESENT PRACTICES

Size Drill Pipe O.D.(in.)	Diameter of Open Hole (in.)	Size Casing O.D. (in.)	Heavy Strings used to date Length (ft.)	Wt. (tons)	Probable future Strings Length (ft.)	Wt. (tons)
8⅝	25 –27	Surface String	1200	38.5	1500	46.5
6⅝	17 –19	13⅜–11¾	5500	86.4*	6500	101.0
5⅞	12 –12½	9⅝–8⅝	7900	100.6*	8500	108.0
4½	7⅝– 8½	6⅝–5¾	8100	78.5	9500	91.5
3½	7⅝– 8½	5¾				
3½	5¾	4¾	9300	69.5	10000	74.5

* Ten lines strung in derrick.

The number of lines strung in the blocks and the speed ratio of the engine to the line shaft are different for setting casing than for normal drill pipe hoisting operations. Consequently, the weights of casing shown previously will be slow-moving loads which the equipment must handle, whereas the lighter drill pipe loads must be moved at higher speeds.

The dead loads given in Tables II and III do not represent the extreme loads produced by pulling on stuck drill pipe or casing. Table IV gives extreme loads to which the equipment may be subjected as calculated by the power output of a 12 by 12-inch twin cylinder drilling engine, with various steam pressures, exerted through either a 3- or 4-speed drawworks.

TABLE IV

CALCULATED PULL ON CASING OR DRILL PIPE POSSIBLE TO EXERT AT HOOK

Steam Pressure at Engine Manifold (lb./sq. in.)	Type of Drawworks	Hook Pull (Tons) Casing 12 Lines	Casing 10 Lines	Drill Pipe 10 Lines	Drill Pipe 8 Lines
150	3-speed	345	288	155	124
175	3-speed	404	338	179	143
200	3-speed	464	387	205	164
150	4-speed	374	313	219	175
175	4-speed	437	365	257	205
200	4-speed	502	420	295	236

Time for Hoisting:

The speed of hoisting is dependent on the weights and power available. Figure 1 shows the horsepower applied at the hook for hoisting different weights of drill pipe at several normal rigs as determined by calculation from observed times and weights. It will be noted that the maximum power which was utilized in Case I is approximately 245 horsepower. It is assumed that the efficiency of the hoisting equipment from the engine to the hook is about 75 or 80 per cent, hence the brake horsepower developed by the engine must be approximately 325. This is exceptionally high for the average rig where the steam pressure at the engine manifold is between 115 and 135 pounds per square inch, but at this particular rig it can be attributed to excessive engine speeds.

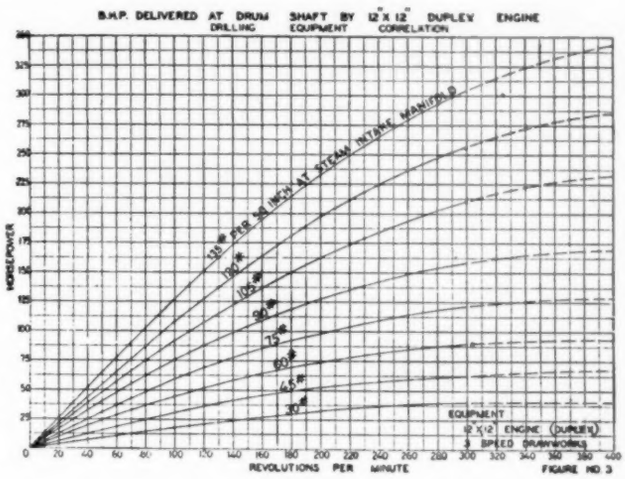


Figure 2 shows the observed average time in seconds required to hoist a stand (4 joints) with various weights of the drill pipe. The time represents normal practice with eight lines strung in the derrick and has been found to be consistent with the observed drilling practice for wells of from 7500 to 8000 feet in depth when steam pressures of 115 to 135 pounds per square inch are available at the engine.

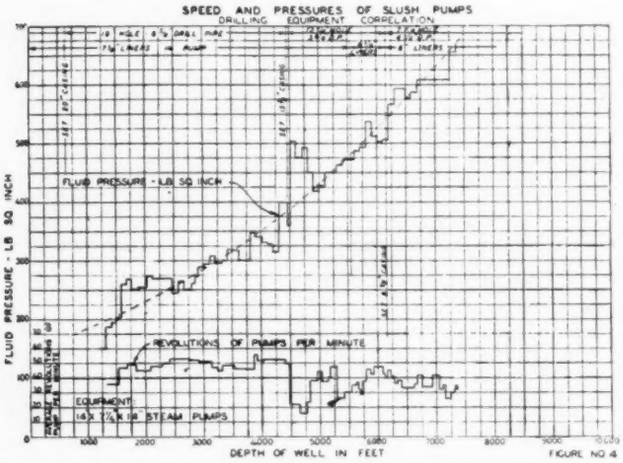
Power for Hoisting Operations:

Figure 3 shows the brake horsepower developed by a 12 by 12-inch duplex rotary drilling engine with various steam pressures at the engine manifold. These power determinations were made at the rotary drum, hence efficiency factors in the chains, sprocket, and shafting between the engine and the drum shaft are included. The steam pressure of 135 pounds per square inch represents the maximum that is generally obtainable at the engine manifold from a setting of 150-pound boilers, because of the loss in pressure represented by line and condensation losses.

The weights of drill pipe which are expected in the near future have been shown in Table III. They are approximately 10 per cent in excess of past practice. In order to hoist the heaviest strings used to date with the present

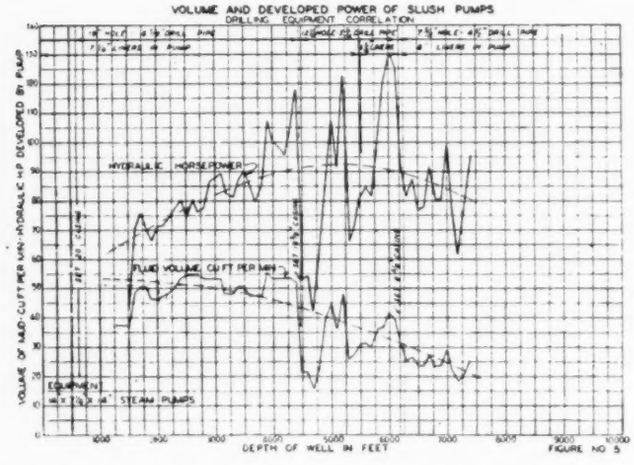
power, it has been necessary to string 10 lines in the derrick. This has reduced the normal hoisting rate of the present heaviest strings by approximately 10 per cent below the observed rates shown in Figure 2. The effective power at the hook for hoisting expected drill pipe loads, therefore, has to be increased by the sum of these two factors, or by 20 per cent, if hoisting of the heavier strings is to be done at a rate comparable to the present practice.

Such an increase in load requires the engine power to be increased by 27 per cent to cover transmission losses in


SPEED AND PRESSURES OF SLUSH PUMPS
DRILLING EQUIPMENT CORRELATION
FLUID PRESSURE - LB SQ INCH
REVOLUTIONS OF PUMPS PER MINUTE
EQUIPMENT
DEPTH OF WELL IN FEET
FIGURE NO 4

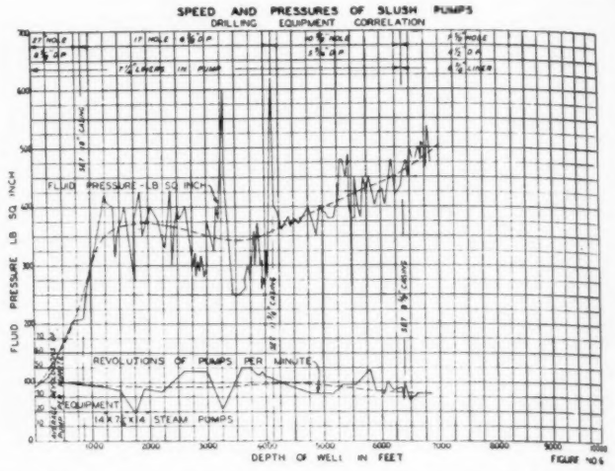
the equipment, thus making it advisable to develop from 325 to 350 horsepower at the engine when it is operating at a speed consistent with its design. The average 12 by 12-inch drilling engine will require steam pressures of 150 pounds per square inch at the engine manifold to attain this power, and this in turn will require at least 175 pounds pressure at the boilers. With unfavorable conditions, such as small or very long steam lines, the boiler pressure will have to be at least 200 pounds per square inch to produce the desired pressure at the engine. With an increase of 20 per cent in the effective power at the hook, the hoisting time for a stand is shown graphically by the dotted line in Figure 2.

If steam pressures of 175 or 200 pounds per square inch


VOLUME AND DEVELOPED POWER OF SLUSH PUMPS
DRILLING EQUIPMENT CORRELATION
HYDRAULIC HORSEPOWER
FLUID VOLUME CU FT PER MIN
EQUIPMENT
DEPTH OF WELL IN FEET
FIGURE NO 5

are available so that the engine will develop, say, 350 horsepower, there will be enough power available to handle casing with the usual sprocket ratios used on the engine and drawworks during casing jobs. A possible casing weight of 250 tons has been previously shown. In Table IV the hook pull with 12 lines in the derrick is shown to vary from 345 tons with a 3-speed drawworks and 150 pounds steam pressure to 502 tons with a 4-speed drawworks and 200 pounds steam pressure. This indicates an abundance of power for normal casing operations. However, in case of pulling on "frozen" or stuck drill pipe or casing, it is impossible to contemplate the power required; but it would not be logical to increase the power over the proposed 20 per cent with the view of meeting this emergency, as this in turn would require that all other equipment be increased to a point where the cost of the rig would be exorbitant.

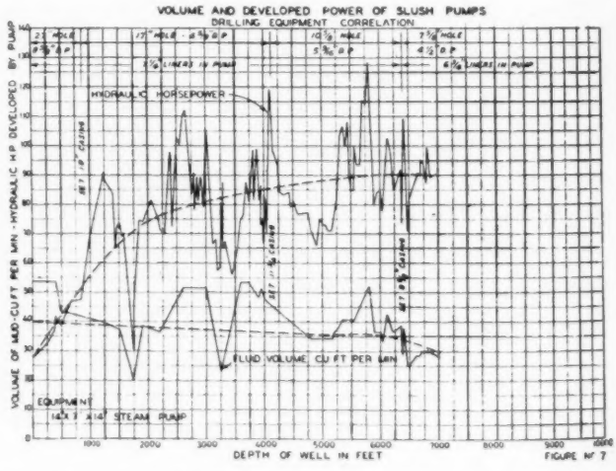
The present common types of 12 by 12-inch twin-cylinder drilling engines are adequate to produce sufficient power for all deep drilling operations expected in the near future,


SPEED AND PRESSURES OF SLUSH PUMPS
DRILLING EQUIPMENT CORRELATION
FLUID PRESSURE - LB SQ INCH
REVOLUTIONS OF PUMPS PER MINUTE
EQUIPMENT
DEPTH OF WELL IN FEET
FIGURE NO 6

provided the required steam pressure is available. It is desirable to increase the steam pressure rather than to increase the size of the engine, for, as will be shown, higher steam pressures are also required for the slush pumps. In light of this study larger engines have not been considered, although in some special instances it may be more economical to obtain the desired increase in power by the use of larger engines and providing pumps with larger steam ends than by resorting to higher pressure boilers. This decision will depend largely on equipment which may be on hand.

Power for Circulation of Drilling Fluids:

There is a wide divergence of opinion among operators as to the size, pressure and volume capacity of the slush pumps. This is to be expected, because of differences in


VOLUME AND DEVELOPED POWER OF SLUSH PUMPS
DRILLING EQUIPMENT CORRELATION
HYDRAULIC HORSEPOWER
FLUID VOLUME CU FT PER MIN
EQUIPMENT
DEPTH OF WELL IN FEET
FIGURE NO 7

formations and drilling practices in the various districts. The quantities of fluid circulated, viscosities and weights of muds, and other similar factors which bear on pumps are all dependent on the particular conditions in a field.

Information on pump pressures, volumes and hydraulic horsepowers has been obtained by field studies in two separate districts. Figures 4 and 5 show the maximum pressures, volumes and hydraulic horsepowers developed in drilling to a depth of 7500 feet in the Ventura field (Cali-

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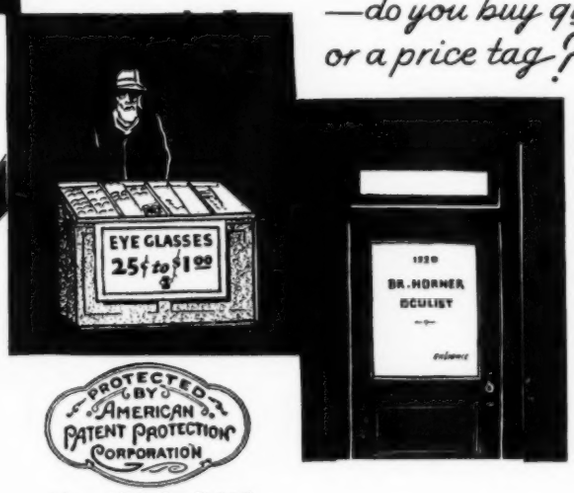

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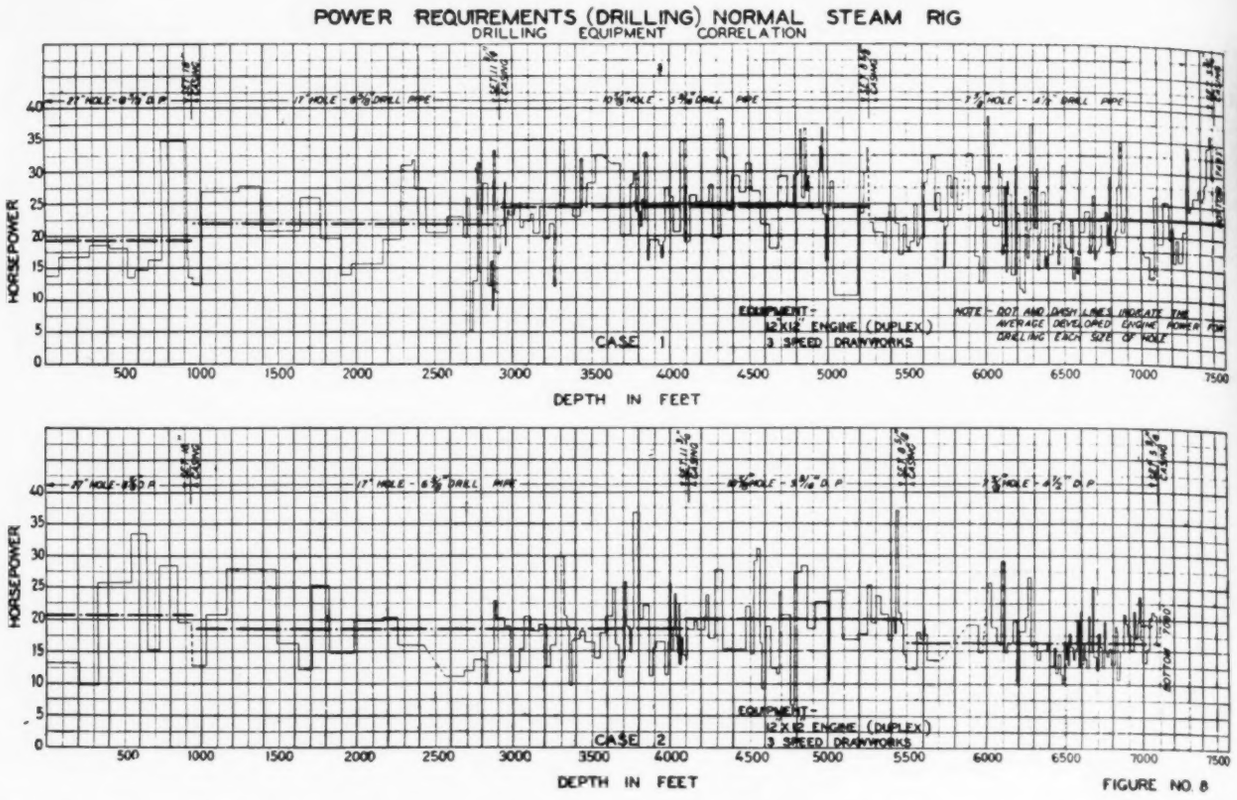


FIGURE NO. 8

fornia). It will be noted that the pressures gradually increase with depth to a maximum of 700 pounds per square inch, while the volumes of fluid circulated decreased from 50 to 25 cubic feet per minute. An average maximum hydraulic horsepower of 92 was developed at slightly over 5000 feet in depth and the maximum peak of 130 horsepower occurred at a depth of 6000 feet.

Figures 6 and 7 give similar data obtained from a typical well in the Santa Fe Springs field (California). Pressures increased with depth in this case until a maximum of 500 pounds per square inch was reached at 7000 feet. The volumes of fluid circulated decreased with depth from 40 to 30 cubic feet per minute, as indicated in Figure 7. Steam pressures at the pumps in both cases ranged from 115 to 135 pounds per square inch, with normal boiler pressures of 150 pounds per square inch.

With the pump pressures increasing steadily at the rate of about 100 pounds for each 1000 feet of depth, it is expected that future pumping pressures may be in excess of 900 pounds per square inch. This will require steam pressures of 175 pounds per square inch at the pumps if 14-inch diameter steam ends are used. Allowing for average steam line losses, boiler pressures of 200 pounds per square inch will be required. This is in keeping with power requirements of the hoisting equipment. Since it has been previously shown, steam pressures of 175 or 200 pounds per square inch are required. These boilers will provide the necessary steam pressures for pumping when the usual 14-inch diameter steam ends are used on the pumps.

Pump pressures higher than 900 or 1000 pounds per square inch may be required for special conditions in some localities, and in this event pumps with either 16 or 18-inch diameter steam ends may be desirable. However, in California higher pressures are usually required only for emergencies, and these can be obtained by temporarily compounding the normally used pumps.

Power for Rotating Drill Pipe and Bits:

The power required for drilling or rotating the drill pipe and bit is a very small part of the total used at a normal drilling rig. Figure 8 shows two cases of the power developed at the engine in drilling wells to a depth of 7500 feet during which various sizes of bits and drill pipe were used. It will be noted that the average power rate is quite constant and is but slightly affected by the size of drill pipe or the size and depth of hole. The maximum power consumption in the two wells are 39 and 37 horsepower respectively.

There is no question as to the adequacy of the present equipment to transmit the power required for future drilling purposes, because with the concerted effort being made by all operators to obtain straighter holes, future drilling power requirements will probably be decreased. This assumption is based on the theory that straighter holes will be produced by decreased bit pressures, although it is also possible that increased speeds of rotation, together with decreased bit pressures, may be the solution of straighter hole drilling. If so, no decrease in power consumption for drilling could be expected. Because of the relatively small amount of power used in drilling, its consideration as affecting future practice is of little importance.

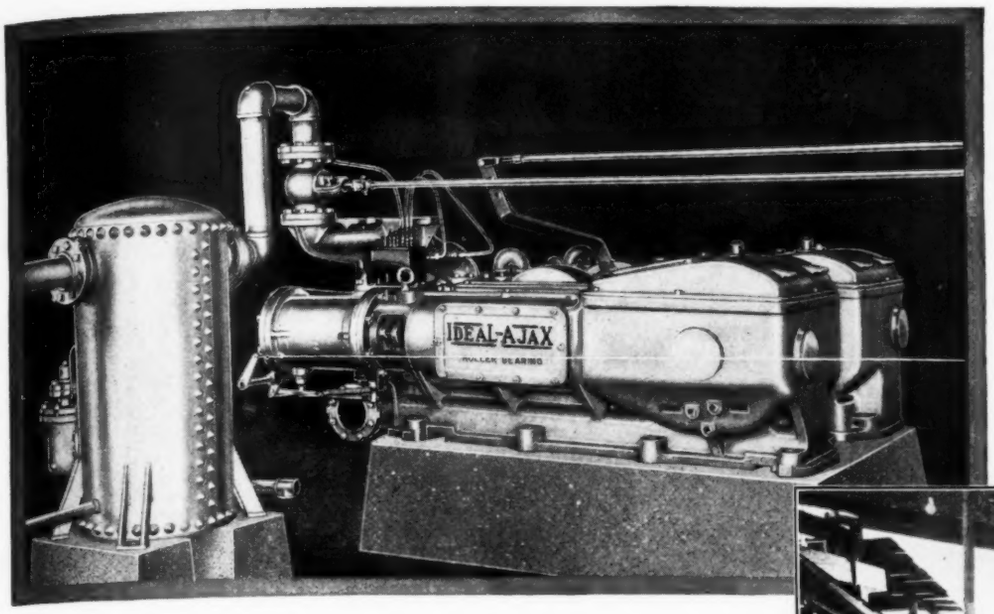
Adaptability of Equipment to Load and Power Conditions

Derrick Loads:

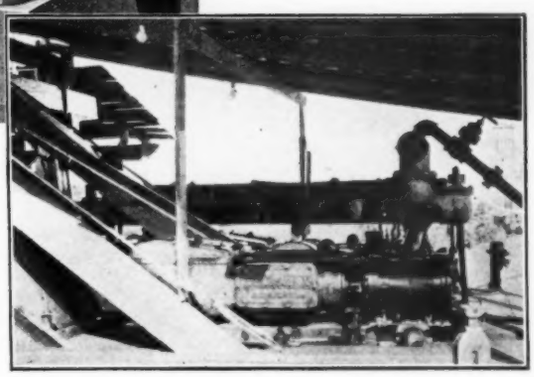
At present 122-foot steel derricks with 24 or 26-foot bases, somewhat of the type shown in Figure 9, are in general use in California. These derricks have an A.P.I. dead-load capacity rating of approximately 225 tons when reinforcing legs are used. These ratings are calculated with a safety factor of at least 2 and it is not considered dangerous to load derricks up to this capacity providing the loads are applied without impact. However, normal loads should not exceed 50 to 75 per cent of the dead-load rating.

There are several factors entering into a theoretical determination of the actual load imposed on a derrick during any particular operation. The most important of these are shock loads, buoyancy, friction, acceleration or deceleration of the drill pipe or casing, and the number of lines strung in the derrick.

The heaviest string of casing set in California to date was 5,080 feet of 13⅜-inch, weighing 212 tons, as shown in Table II. Twelve lines were strung in the derrick during



12x12 Twin Roller Bearing Engine with Piston Valves, Large Capacity Steam Separator and Trap, Locomotive Type Drain Valves, Relief Cocks, and Three Feed McCord Lubricator.



IDEAL-AJAX 12x12 Twin Roller Bearing Engine in operation at Maud, Okla.

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the operation, and the casing was "floated" in. A float valve was placed at the shoe and the fluid inside the casing was kept at a level of approximately 1,000 feet below the top. The combined effect of buoyancy, "floating," friction, number of lines, and weight of block and elevators reduced considerably the actual dead load on the derrick.

In handling drill pipe the loads imposed on the derrick are usually much more erratic, but seldom exceed the loads resulting from heavy strings of casing. The heaviest string of drill pipe used to date consisted of 7,900 feet of 5 9/16-inch weighing 101 tons, including tool joints and drill collars, as indicated in Table III. Ten lines were strung in the derrick, and with the effect of buoyancy considered, the weight imposed was probably about the actual weight of the pipe. No accurate data are available on the additional loads imposed on the derrick due to acceleration, deceleration, friction, or pulls on stuck pipe and drilling tools.

Figure No. 9
Typical 122 Foot Derrick

Under normal drilling conditions the loads due to acceleration or deceleration usually will not exceed five per cent of the weight of the drill pipe. In certain cases, however, shock loads in excess of 100 per cent of the weight of the drill pipe have been recorded on the weight indicators. The additional load due to friction varies considerably depending on the condition and size of the hole and probably, in some cases, amounts to 15 per cent of the weight of the drill pipe. It is impossible to estimate with any degree of accuracy the loads that are imposed on the derrick by pulling on stuck pipe or drilling tools, however, a maximum load would be the pullout strength of the joints which in the case of 8,500 feet of 5 9/16-inch drill pipe is over twice the weight of the pipe.

Wire Line Loads

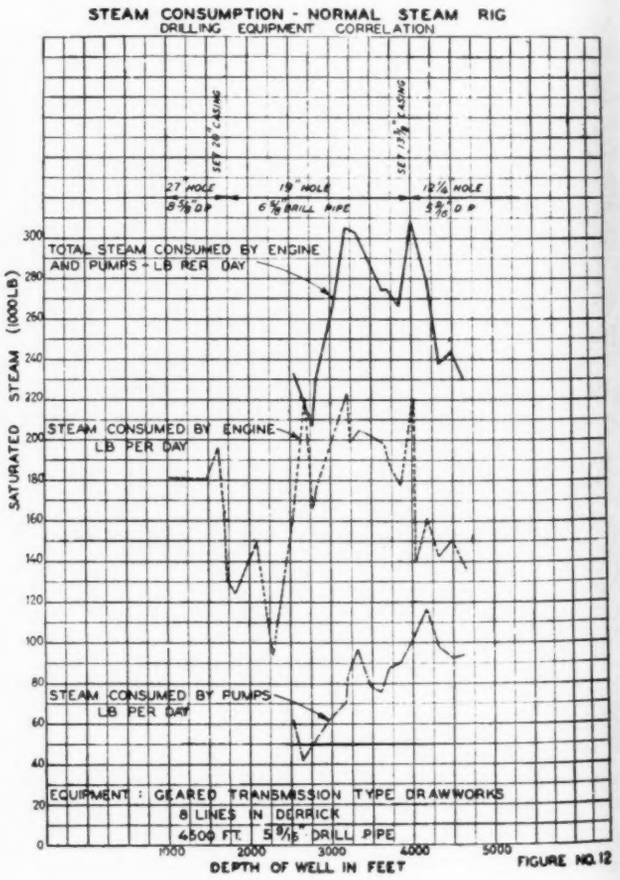
At present 1-inch plow steel A.P.I. Grade J lines are used quite extensively for drilling and for setting casing. However, some operators use 1-inch super plow steel lines for setting heavy strings of casing and a few operators use the higher grade lines for both drilling and setting casing.

The loads on the wire lines are constantly increasing and it may be necessary in the near future to use lines with a greater tensile strength in order to handle the strings of drill pipe and casing resulting from deeper drilling. Future practice will be governed more or less by past experience, that is, the factor of safety for the tensile strength of wire lines will be governed by that found satisfactory in the past.

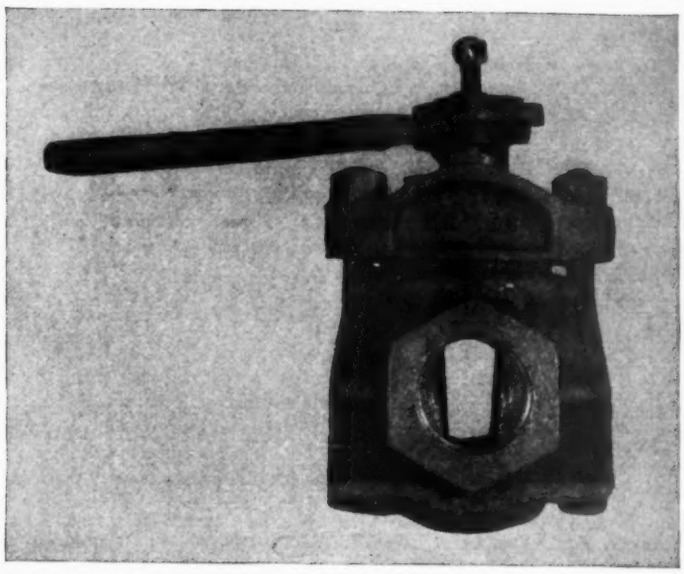
There is some difference of opinion relative to the use of 8 or 10 lines for handling drill pipe. The increase to 1¼ inch lines for drilling will be gradual, as 10 lines of the smaller diameters will be used until the use of 1¼-inch lines is established. However, the use of a smaller number of larger diameter lines will probably give better line service and make their use desirable because of lower speeds both in line travel and equipment.

Although the general practice will be to use plow steel lines, some operators, as in the past, will use the super steel lines for both drilling and setting casing, and a few operators will use super steel lines for setting casing and plow steel lines for drilling.

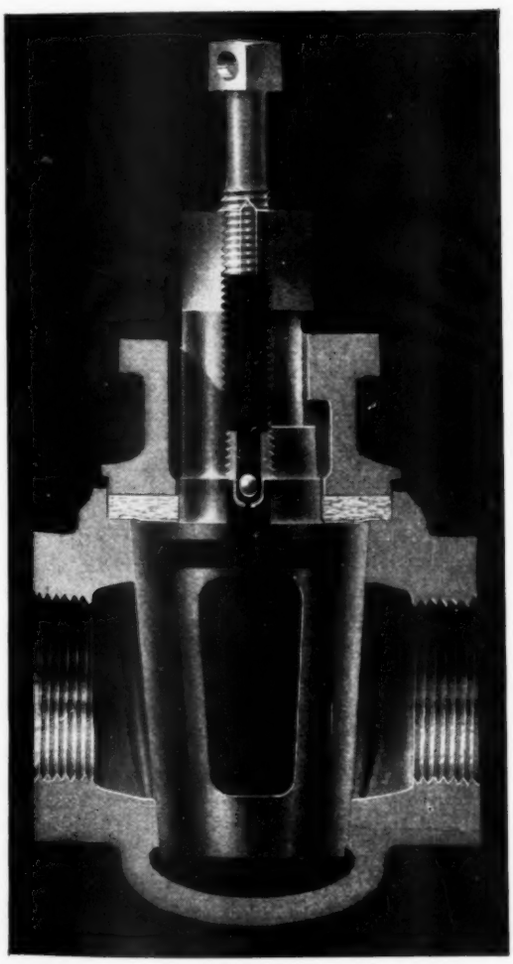
Unlike the other rotary drilling equipment, different types and sizes of wire lines can be used for the different depths. For instance, by the use of sheaves so designed that 1, 1⅛, or 1¼-inch lines can be used, a considerable saving will be effected in wire line service costs by the use of 1-inch lines for the lesser depths and the larger lines as required with the depth developments. Future practice will greatly depend on experimental work to determine the best design in regard to sheave sizes and other related information.


STEAM CONSUMPTION - NORMAL STEAM RIG
DRILLING EQUIPMENT CORRELATION
SET 20" CASING
SET 13⅜" CASING
27" HOLE
19" HOLE
12¼" HOLE
TOTAL STEAM CONSUMED BY ENGINE AND PUMPS - LB PER DAY
STEAM CONSUMED BY ENGINE LB PER DAY
STEAM CONSUMED BY PUMPS LB PER DAY
SATURATED STEAM (1000 LB)
EQUIPMENT : GEARED TRANSMISSION TYPE DRAWWORKS
8 LINES IN DERRICK
4500 FT. 5 9/16" DRILL PIPE
DEPTH OF WELL IN FEET
FIGURE NO. 12

MERCO



More than 1,000,000 turns



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Boiler Ratings and Steam Consumptions:

Boilers for oil field purposes may be classified as high or low pressure, depending on whether the pressure for which they are designed is under or over 150 pounds per square inch. Boilers for 150 pounds steam pressures are in the low pressure class. The use of boilers for high pressures (175 to 200 pounds) has been discussed as the logical means of increasing engine powers to meet deeper drilling conditions. In these pressure ranges the selection of power rating or sizes depends largely on the corresponding weights as the boilers must be transported with the usual field transportation equipment. The maximum size for convenient transportation at the present time is an 85 horsepower, 200-pound pressure boiler, and larger sizes in most cases will result in a special transportation problem, especially for long moves.

Many operators are using 150-pound boilers due largely to having boilers of this pressure rating on hand. When such boilers are used, the steam pressures at the engine and pumps are in general within a range of from 115 to 135 pounds per square inch, due to losses in the steam lines. One operator is using a separately fired superheater and large steam lines in order to maintain the maximum pressure at the engines and pumps when using low-pressure boilers. A detail of the superheater is shown in Figure 10, and its location in a boiler setting is shown at the right-hand end of the setting in Figure 11. The steam is superheated 100 degrees Fahrenheit by means of the superheater and retains an average of 25 degrees Fahrenheit superheat when it reaches the rig. A better quality of steam is obtained by this means, and larger steam lines can be used without excessive condensations; thus higher pressures may be obtained at the points of consumption.

However, with the use of 175 or 200-pound pressure boilers, the required pressures can be obtained at the rigs with smaller steam lines. The high-pressure boilers also have the advantage of a greater volume of reserve steam storage for peak consumption.

Figure 12 shows the metered steam consumption for normal drilling operations, as developed in a bank of 150-pound horizontal return tubular boilers. The steam consumed by the pumps and engine is shown separately, and a third graph indicates the total consumption. This information was obtained during drilling operations with a 10 by 10-inch three-cylinder engine and may vary slightly from the amounts used at rigs with 12 by 12-inch duplex engines. However, for practical purposes the steam consumptions shown are representative. It will be noted that the maximum consumption is about 300,000 pounds daily. Oil field boilers, according to the generally accepted figures, evaporate about 6 pounds of water per hour for each square foot of heating surface. At this rate, three or four 85-horsepower boilers will generally provide sufficient steam for one drilling rig with a reasonable excess capacity to provide for radiation and other losses.

Rotary Chain Duty:

The duty on rotary chain will be increased by the additional power provided for the handling of longer strings of drill pipe and casing.

Tensile strength tests on rotary chain obtained from manufacturers' test data show yield points of approximately 65,000 pounds for number 3 as used for drilling, and 110,000 pounds for number 4 chain used for hoisting. It is possible that a comparison based on yield strengths does not give a true indication on the service to be expected from the chain.

Swivel Loads:

The swivels now used have been designed for rotating drill pipe loads of from 90 to 100 tons and have reached their theoretical load limit with the present weights of drill pipe strings. With a future increase in weight, a heavier type of swivel will undoubtedly be required, and heavier designs are now contemplated. The dead load capacities of swivels have not been definitely established, but actual pulls sufficient to break 1-inch wire lines with 8 lines strung have occurred. This indicates that the present swivels have a possible dead load capacity in excess of 300 tons. In increasing the capacity for rotating loads the dead load capacity should be increased at the same time to be consistent with the greater future pulling power of the equipment and load capacity of the derricks.

Conclusions:

In the past, rotary equipment has had a gradual development to meet advancements in drilling. It is not the policy of any operator to discard usable equipment in order to obtain heavier equipment which is possibly more suitable for meeting the increased demands due to greater depths. Normal advancements will probably take place somewhat along the lines outlined in this paper, but no complete changes or radical re-designs in all drilling equipment are foreseen at this time.

The increase in load capacities of derricks and wire lines appears to be of the greatest immediate importance, and in order to maintain present drilling speeds the power for hoisting should be increased in proportion to the loads. This should come preferably through higher steam pressures than through larger engines. The design and construction of the other parts of drilling equipment will necessarily have to be consistent with these major items. By such gradual development a completely equipped rig suitable for greater depths will be attained.

New Gas Lines in the San Joaquin Valley

A MAJOR undertaking of the Southern California Gas Co., subsidiary of the Pacific Lighting Corp., was development work in the Kettleman Hills fields. Since last spring the company has been busy constructing a pipe line from Kettleman Hills to various San Joaquin Valley towns, and recently three lines were completed.

These comprised a 10-inch line from Kettleman Hills to Lemoore Junction, an 8-inch line from Lemoore Junction to Fresno, and a 6-inch line from the Junction to Visalia. While these transmission lines were being laid, distribution systems were installed in the San Joaquin Valley towns to Lemoore and Armona. A 4-inch lateral from the Fresno line through the Dinuba district system is to complete the change from manufactured gas to natural gas.

The natural gas system from Kettleman Hills to the Valley was tested completely, and natural gas was introduced into the Hanford district, followed a few days later by natural gas in the Visalia district. Recently natural gas was supplied to Tulare and vicinity.

Pacific Gas & Electric has completed arrangements in its Fresno district, and shortly will introduce natural gas in the raisin belt. Southern California Gas also is constructing a pipe line from Kettleman Hills to the Buena Vista Hills terminal, where it is planned to connect a line with existing lines into Southern California. The two transmission systems at present under construction in the San Joaquin Valley entail an expenditure of approximately $3,125,000.

Booklet Tells of Institute's Work

"What Does the Institute Do?" a booklet describing the work of the American Petroleum Institute and incorporating the address of President E. B. Reeser before the tenth annual meeting at Chicago, December 2-5, has been given general distribution by the organization. Copies are available upon request and without cost to those interested.

FISHER TYPE 2200 MASTER CONTROLLER

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TYPE 2200 MASTER CONTROLLER

The illustration shows a Fisher type 2200 Master Controller furnishing constant gas fuel supply, as to quantity and pressure, to the engines at the Earlsboro, Oklahoma, plant of a major operating company.

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Cylinder Stock Treating and Sludge Disposal

By H. L. SMITH,
Pure Oil Company

THE matter of treating Mid-Continent cylinder stock and the disposal of the sludge therefrom has long been a vital question to the Mid-Continent Refiners but never to the extent that it has during the last two or three years or since the demand for bright stock has become so strong that Mid-Continent bright stock can compete with Pennsylvania stock and yet be profitable to the refiner.

Before the Mid-Continent refineries started making bright stock on a large scale practically every complete refinery in the district had a sludge acid pond in or near the plant to which the small amount of sludge made was hauled by various conveyances and the accumulation burned at various intervals. These ponds although serving the purpose were always an eyesore and when the sludge output was increased ponds were out of the question and the matter of burning sludge acid came into the picture.

Cushing crude is being run continuously at the Muskogee Refinery of the Pure Oil Company through a battery of one tube still and eight shell stills and the crude bottoms taken from the eighth shell still are pumped as steam defined cylinder stock to storage tanks. In order to have a uniform stock great care in manipulation of steam in the various stills is absolutely essential.

In blending cylinder stock with Sharples naphtha for the purpose of making a blend that can be most readily treated we have, after considerable experimenting discovered that a blend with a viscosity of about 225 at 100 is the most suitable. It has been found that the temperature of the blend being treated must be held below 100 degrees in order to get the best results from the acid being used.

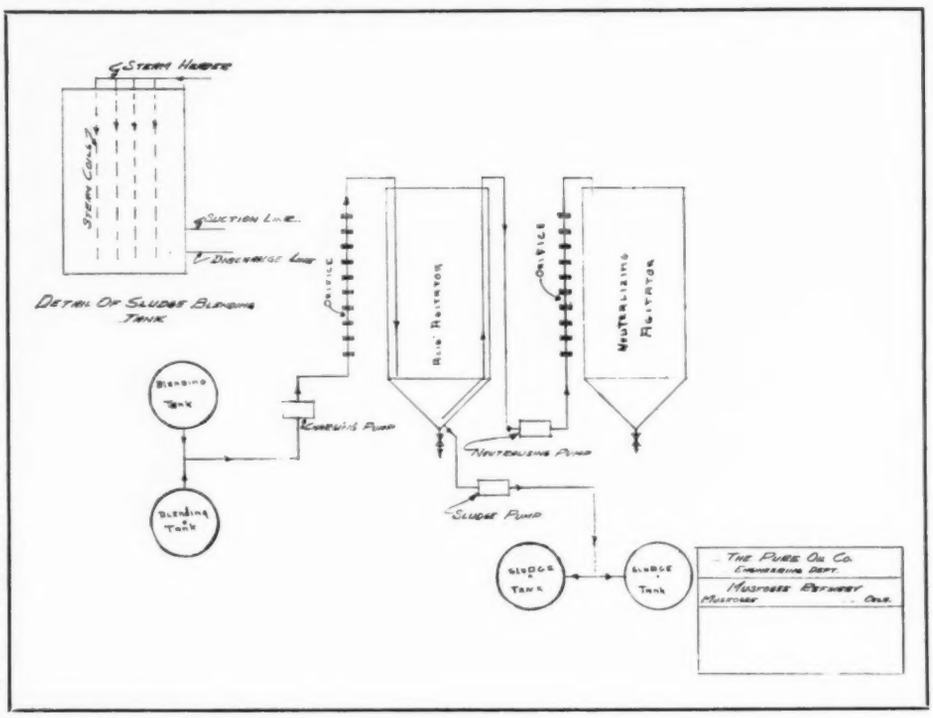
At temperatures higher than 100 degrees too much agitation due to vapors is incurred which causes the excess acid in the oil to be more or less re-agitated and thus a sulfonated oil is obtained that has a dark color, bad cast and is very difficult to filter.

In treating the cylinder stock mixture an electric driven rotary pump is used which takes suction from the blending tank and discharges through a series of ten-inch orifice plates into the acid agitator. 98 acid is introduced into the pump discharge by means of air pressure from a large acid blow case. Great care must be taken at this step of the operation in order that an even amount of acid is introduced at all times. In order to get the proper contact between the oil and acid going through the orifice plates a pressure of approximately 60 pounds is carried on the pump discharge and slightly higher pressure on the acid blow case. In order to minimize the evaporation loss on the cylinder stock mixture the pump discharge line is carried too near the bottom of the acid agitator.

After a few barrels of the acid treated mixture have been pumped into the acid agitator sludge can be removed from the bottom as the heavy sludge starts settling very quickly and by starting to remove it at the earliest possible moment larger treats can be handled due to the fact that when the agitator is full practically all of the sludge has been removed. The equipment used in handling the heavy sludge is a Dean Bros. 12 x 6 x 12 ram pump. This pump is placed directly beneath the agitator in order that the sludge will get a free fall to it. The heavy sludge is pumped then to a 1000-bbl. mixing tank where it is blended with fuel oil and is ready for burning purpose.

The acid treated oil is allowed to settle overnight in the acid agitator and is then pumped through another series of orifice plates into the neutralizing agitator. At the same time this oil is being transferred a weak solution of caustic soda is being introduced into the suction line of the transferring pump and by the time the solution enters the second agitator it is slightly caustic. After settling and drawing off the caustic solution the now neutral solution is ready for filtering.

The thousand-barrel tanks used for blending sludge with fuel oil are equipped with four one-inch pipes extending from the top of the tank in the center to within a foot of the bottom. Through these lines live steam is introduced which acts as the agitating agent as well as keeps the temperature up on the sludge mixture. No heating coils are used in these tanks. A temperature of around 180 degrees is carried on the sludge oil and by using live steam it is possible to pump fresh sludge into the same tank that our plant fuel is coming out of.



The control of high pressures while drilling or producing is our zone of endeavor, and we have staked our claim in all the high pressure fields of the world. Engineers everywhere show their confidence in SHAFFER EQUIPMENT, and for modern deep holes, heavy casing strings and extreme pressures, they are demanding Shaffer products.

Photo shows five thousand-pound cellar set-up for Kettleman Hills. The assembly is 100% Shaffer design and manufacture, and consists of high-pressure mud-cross, flanged to casing, a Control Gate with complete shut-off rams, (replacing old-style drilling valve) then a Control Gate to close round drill pipe — and for additional protection and convenience, our famous Warren Control Head which is the safest blowout preventer of the packing-assembly type made, with a built-in overflow connection and flanged Christmas-tree cap.

Most of the serious fires and blow-outs occur during actual drilling operations, or while drill pipe is in use, when the drilling valve cannot be operated. Unexpected pressures encountered while drilling is in progress can be controlled with the Shaffer Cellar Control Gate in the same manner that a shut-off is obtained in open hole with the ordinary type of valve now in use.

With this control gate installed in the cellar, a shut-off can be made while the well is flowing, in a much simpler manner than by attempting to place packing in the regular type of blow-out preventer when the well is out of control.

Two of these gates are recommended for a safety set-up, one to close around drill pipe, and one to function as a drilling valve, closing open hole. The design is so compact that two of them occupy practically the same space as an ordinary drilling valve.

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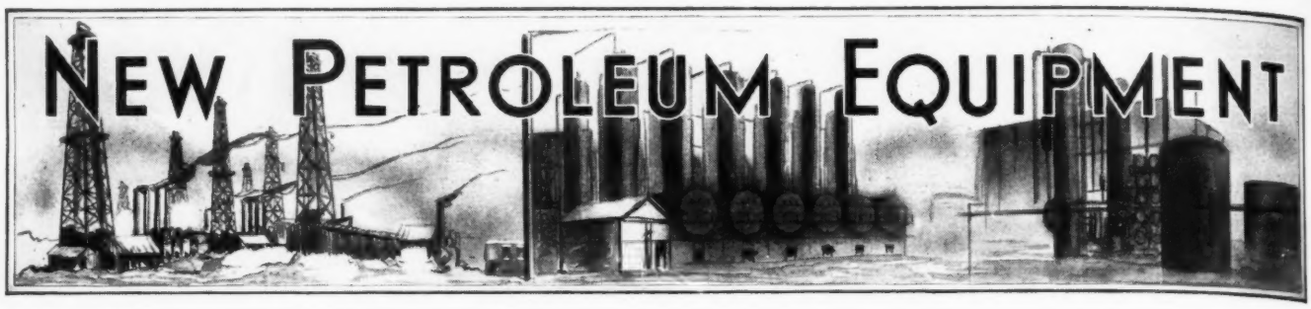
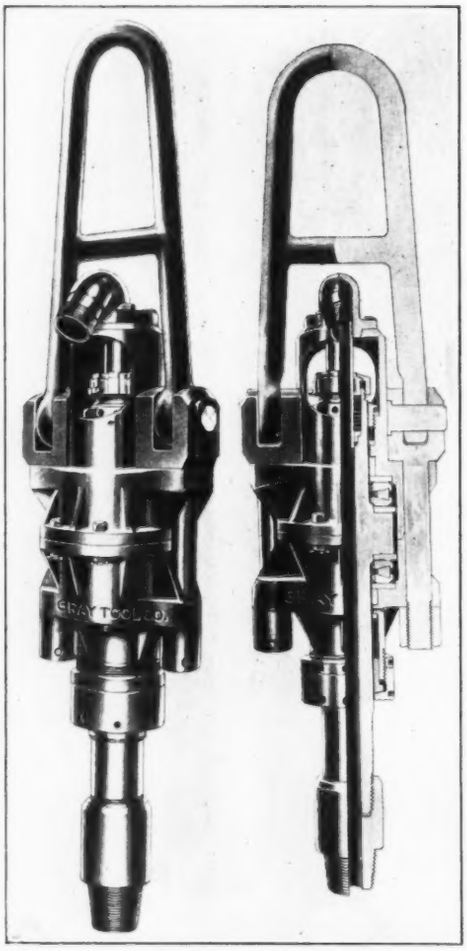


New Features in Oil Well Swivel

THE Gray Tool Company of Houston, Texas, has recently introduced a new Timken-equipped oil well swivel incorporating several novel features of design and construction. The new swivel is especially suitable for heavy duty service, emphasis having been placed on strength and simplicity in assembly.



One of the interesting features of the swivel is the method of suspension that has been adopted. This consists of a bail which, instead of being fastened over gudgeons, is bolted to the tops of two heavy bolts which extend the length of the swivel body. The bolts are carried with lugs, and are held at the bottom by heavy screw caps. The bail proper is braced by a transverse member, which prevents pulling together and permits lighter construction of the bail itself without reducing strength.

The method of support has several advantages. It permits lifting the load through a straight pull on the bail bolts and from the bottom, thereby eliminating tendency toward distortion or pulling together of main swivel body and avoiding the cramping of working parts. Further, the load on the bearing is equalized, saving wear on parts, and prolonging the life of the apparatus.

The rotating member is carried on two Timken thrust bearings, one above and one below shoulder on swivel stem. By virtue of this construction ease of rotation is secured, as well as sufficient strength to withstand the shock loads encountered during spudding, and the use of blocks to obtain additional weight on the bit when rock is encountered near the surface is permitted and provided for.

Alemite systems of lubrication is employed and sufficient space is left in the bearing housing to serve as a reservoir permitting oil bath for all working parts. Lower oil bath packing gland and wash pipe gland can be packed without the inconvenience of inserting packing through threads. The goose neck is attached with bolts instead of studs. The swivel is easily disassembled without the necessity of spreading bails over gudgeons. Each part is so designed to assure that the heaviest drill pipe will pull in two before any distortion whatsoever occurs. General specifications: Total weight, 1,875 lbs.; 3 inches in diameter with 3-in. cross brace to prevent spreading or pulling together. Bearings, 2 Timken T. C. 702; length over all, 8 ft. 2 in.; width over all, 2 ft.; inside diameter of wash pipe, 2¾ in.; hose nozzle connection Boss Acme or A. P. I. stem connection, 6-in. left hand A. P. I.

New Firm For Export Business

THE Emsco Derrick & Equipment Company and The Continental Supply Company announce the formation of a company to conduct their foreign and export business.

The Emsco Derrick & Equipment Company's office at 150 Broadway, New York City, and the Continental Well Supply Company's office at 74 Trinity Place, New York City, have been dissolved and the business of both The Continental Supply and the Emsco Derrick & Equipment Company will be conducted under the new firm of The Continental-Emsco Company, Inc., located at 74 Trinity Place, New York City.

F. L. Convers, who was formerly in charge of the Emsco Derrick & Equipment Company's New York office, is in charge of the new corporation. Mr. Convers has been long known in connection with the supplying of oil well drilling and production equipment to foreign fields, having spent many years in London, Roumania, Russia, Mexico and South America.

New Catalogue on Nordstrom Valves

A NEW catalogue has just been issued by Merco Nordstrom Valve Company featuring Nordstrom Valves in the various sizes with pressures ranging from normal to 1500 lbs. A large number of mechanical detail drawings are also shown, indicating the construction of the various types of valves. Interesting information is given on the various types of lubricants to be used in lubricated valves at different temperatures from 20° to 350° F., and specific information regarding the type of lubricant to use for different contents within the pipe line. A large number of new illustrations showing application and installation of Nordstrom Valves are shown in the catalogue. Various tables of interest to the engineer are also included. Copies of the enlarged edition may be obtained from any of the offices of the company located in different parts of the country, or by communicating with the head office, 343 Sansome St., San Francisco.

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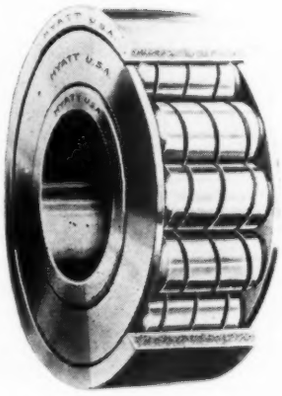

The Hyatt Roller Bearing with outer race cut away to show construction of roller assembly. Our engineers will gladly submit bearing designs for any application in which you are interested.

Equipment lasts longer when rugged Hyatts are employed. Immunity from bearing breakdowns insures faster, smoother production. Attention is confined to infrequent lubrications. Labor and maintenance costs are negligible.

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HYATT ROLLER BEARING COMPANY
Newark Detroit Chicago Pittsburgh Oakland

When writing HYATT ROLLER BEARING CO. *please mention The Petroleum Engineer*

Mission Rotary Slip

AS will be noted from the illustration, this New Rotary Slip is provided with replaceable gripping bodies which operate in a manner entirely new to the field of pipe gripping mechanisms.

Each tooth, or dog, is free to move independently of the others and is so curved on the back and front edges that,

when inclined upwards by the lifting up of the drill stem, the gripping surfaces roll away from the pipe and assure immediate release. Conversely, when the pipe is lowered into the slips the dogs roll back to the horizontal position, pressing against the pipe as they do so. The gripping surfaces of dogs are flat and about one-half inch in width, thus making it impossible to cut or mar the pipe, and, due to the greatly increased gripping area, substantially reducing the danger of swedging in the drill stem. The dogs roll on a comparatively soft steel plate which quickly adapts itself to any possible unevenness of the dogs, while the rolling action reduces the wear on the dogs almost to the vanishing point.

Thorough field tests have proven that this slip will function perfectly with both light and heavy strings of pipe, while ten weeks of service on a well over 5,000 feet deep has caused no apparent wear on the dogs. This slip is manufactured by Mission Sales Co., Inc., Houston, Texas.

Booklet on Fluid Packed Pumps

"The Fluid Packed Pump, Its Construction, Operation, and Performance," is the title of a booklet being distributed by Robert N. Atmore Company, Tulsa, Oklahoma, Mid-Continent distributors of this product. The book treats many phases of the difficulties encountered in pumping oil wells, and describes the types, sizes and uses of Fluid Packed Pumps. It is well illustrated, showing in cross sections the removable and rigid type. It also contains a graph showing the theoretical capacities of the pumps.

Total gasoline tax collections in the first six months of 1929 were $175,140,140 against $140,635,398 for the first half of 1928, an increase of $34,504,742.

National Tool Announces Appointments

ANNOUNCEMENT has recently been made by National Tool & Metals, Inc., of Torrance, California, manufacturers of hard set metals and oil field specialties, of the appointment of two new men to their metallurgical and sales force.

N. W. Cole is the new National addition to their metallurgical staff. Mr. Cole, who for 17 years has been engaged in the business of making and inventing metals, is a graduate of Purdue University. Upon receipt of his degree in chemical engineering, he joined the staff of the Inland Steel Company of Chicago, serving with this concern for 8½ years. Following this, he acted as superintendent of open hearth work at the Utah Steel Corporation, keeping this position for 1½ years, at which time he resigned and took over the metallurgical management of the Alloy Steel & Metals Corporation, of Los Angeles. At this concern he spent 4 years, leaving there in 1926 for the Stoody Company and held his position there until leaving for National Tool & Metals, Inc.

The other addition to the National forces is George N. McGarvey who has been appointed salesman for the Los Angeles City territory. Like Cole, McGarvey is well known throughout the realms of the oil fraternity, having served the industry for the past fifteen years as supply man, advertising manager and sales representative. For 7 years McGarvey was affiliated with the Associated Supply Company. At the end of this period he assisted in opening up the Mid-Continent field for the Sargent Engineering Corporation of Los Angeles. Following 4 years of service with this concern, he became connected with the Grinnell Company of the Pacific, a position which he held for 4 years, or, until his present affiliation.

Foam Generator For Fire Fighting

THE development of the Foam Generator for the continuous production of foam to extinguish oil fires has many advantages over the old two solution equipment. The deterioration of chemicals in storage is eliminated. The portable apparatus is easily handled and moved to the locality of the fire. It can be used at any location where sufficient quantity and pressure of water are available.

This modern oil fire fighting apparatus generates a continuous foam stream from fresh chemicals, as it is needed.

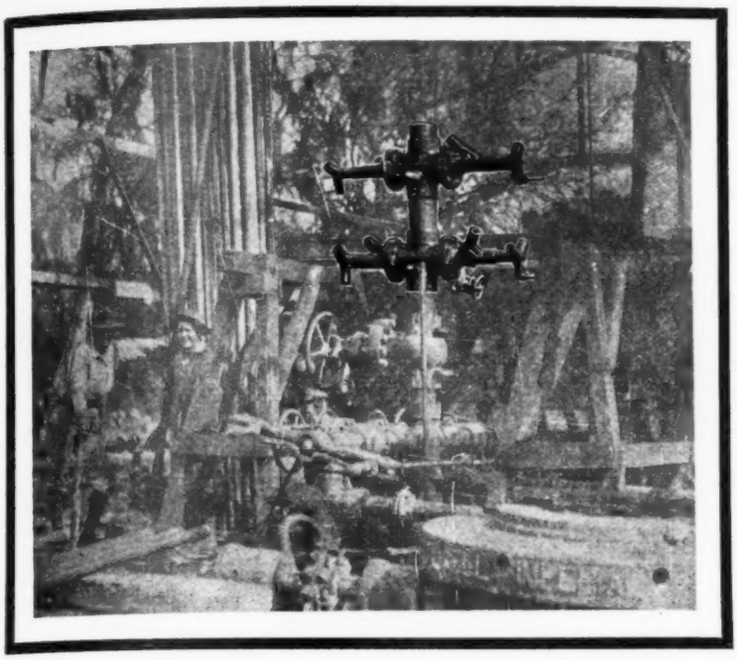
The apparatus, manufactured by the American Fomon Company, Philadelphia, has been approved by the Underwriters' Laboratories.

Nebraska to Have Gas Pipe Line

THE Nebraska Pipe Line Company, of which Clement L. Studebaker of Chicago is president, has incorporated for $1,500,000 and has started the construction of pipe lines to cities and towns in southern and central Nebraska, where an affiliated company, the Nebraska Natural Gas Co., has secured franchises. These are: Crete, Wilber, Ashland, Chester, Deshler, Fairfield, Clay Center, Harvard, Sutton, Blue Springs, Syracuse, Wahoo, Davenport, Edgar, Shelton, Wood River, Hebron and Gibbon.

New Development in Lube Units

"A New Development in Lube Units," is the title of a rather unusual folder picturing the installation of the new Govers Process Lubricating Oil Vacuum Still at the Lawrenceville, Illinois, plant of the Indian Refining Company. This piece of literature is distributed by The Brown Instrument Company of Philadelphia.



Set-up for safely running tubing in high pressure wells, *using*

C-I-W Tubing Control Heads

It is a known fact that to kill a producing well, to run tubing is a risky job. It quite frequently results in a complete shut-down and at best is a difficult, expensive and unsatisfactory method.

With our two control heads mounted one above the other and by snubbing in the tubing one length at a time it is possible to run it against any well pressure. The process is as follows: A length of tubing is snubbed down by means of a device hooked up on an ordinary rig so that a downward force is applied to the tubing by pulling up with the traveling block. Both control heads are released only enough to permit the passage of the tubing. When a coupling is reached the lower control head is closed more securely and the upper head opened. This allows the coupling to pass. This same procedure is repeated until the coupling is beyond the lower control head. By following this same process very little time is required to snub in a complete string of tubing.

The outstanding advantage that the C-I-W tubing control heads have over other methods is that the manually operated locking screws which close the steel rams around the tubing may be tightened to any degree of tightness. A quick acting ratchet device for fast operation of the rams in packing off around the tubing and for opening them to allow the couplings to pass is an exclusive feature.

These tubing control heads are made in two types, the HEAVY DUTY type tested to 6000 pounds pressure and the REGULAR type tested to 1200 pounds pressure.

Write for pamphlet describing this process in detail.

California Distributor:

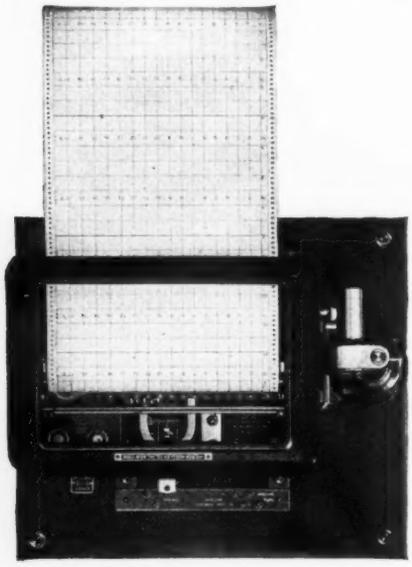
Petroleum Equipment Co.
2800 S. Alameda St.
Los Angeles, Cal.

CAMERON IRON WORKS INC.
HOUSTON TEXAS

When writing CAMERON IRON WORKS, INC., *please mention The Petroleum Engineer*

New Recording Pyrometer

A NEW Potentiometer Recording Pyrometer developed by Wilson-Maeulen Company, New York, has a temperature record chart 12″ wide, and shows a number of other new features of mechanical and electrical design. In this



potentiometric recorder, when the measured voltage from the thermocouple changes, as a result of temperature change at the thermocouple, the galvanometer pointer deflects in the corresponding direction.

At intervals of 10 seconds a boom descends and grips the pointer firmly while two sensing fingers, moving in a vertical plane, approach the pointer from each side, exploring for the location of the pointer, and if either finger finds the pointer deflected and away from its central or null position, a roller ratchet dog is released by the finger, causing a drum to turn.

By means of a violin string, wound around the drum and passing over pulleys at each side of the chart, and attached at opposite sides of a carriage, the motion of the drum in either direction is transmitted to the carriage which is adapted to travel back and forth across the whole instrument.

The carriage carries the pen which marks the chart in its travel, and a contact brush that rides on the potentiometer slide wire.

Folder on Keckley Valves

A folder describing the Keckley Refinery Oil Level Gauges with automatic safety ball check valves, has been distributed by the O. C. Keckley Company of Chicago, Illinois.

Electric Heat in Industry

This very attractive catalog has been mailed out by the General Electric Company and gives an exhaustive report on the advantages of electric heat for industrial uses. It covers a broad variety of installations in a great many different industries.

Emsco Outfit in the Far East

If you care to go "Somewhere east of Suez" and go far enough you will probably encounter the driller pictured above. He is Jac A. Williams with his copper-colored crew running an Emsco rotary outfit.

Roller Chain Data Book Issued By Link-Belt

LINK-BELT COMPANY, Indianapolis, Indiana, has just published a new Roller Chain Data Book, No. 1257, which they claim is the most complete manual for properly selecting and applying chain yet developed.

This 96-page book illustrates the construction of the chains and wheels, and presents many pages showing practical applications of Link-Belt Roller Chain on light and heavy duty industrial drives, and on all types of machinery, tractors, trucks, farm implements, etc.

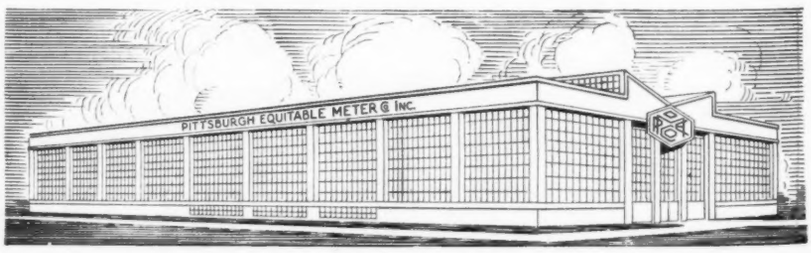
All data is clearly compiled to enable one to select the proper chain and wheels to suit individual conditions, and to figure costs. Also an additional feature of value is a presentation of lists of wheels up to 81 teeth. All pitches of chains are carried in stock.

This book is worthy of an important place in every engineer's and mechanical man's library. A copy will be sent gratis, if requested upon business letterhead.

Barrett Robishaw Coring Bit

The Reed's Barrett Robishaw Combination Drilling Coring Bit is described in a color folder which has been distributed by the Reed Roller Bit Company, Houston, Texas.

SHORTLY following the announcement of an important expansion program, the first step of which was the erection of a new building adjoining the present plant in Pittsburgh, the Pittsburgh Equitable Meter Company announces the second step—a branch factory to be erected at Tulsa, Oklahoma, devoted to the manufacture and servicing of Emco Gas Meters and Regulators; Pittsburgh Gasoline, Oil and Water Meters.

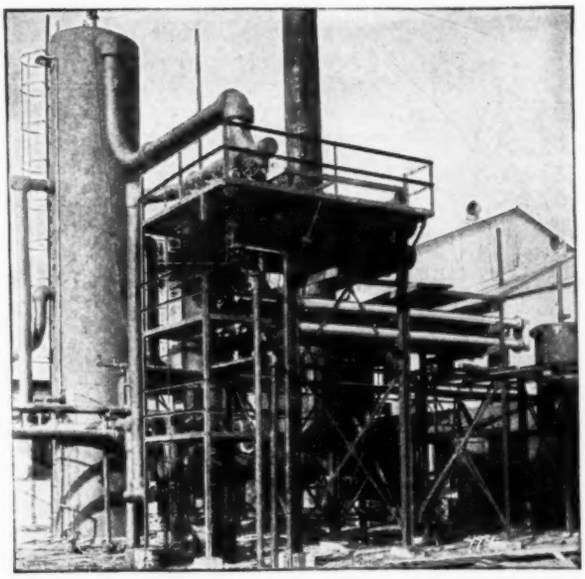


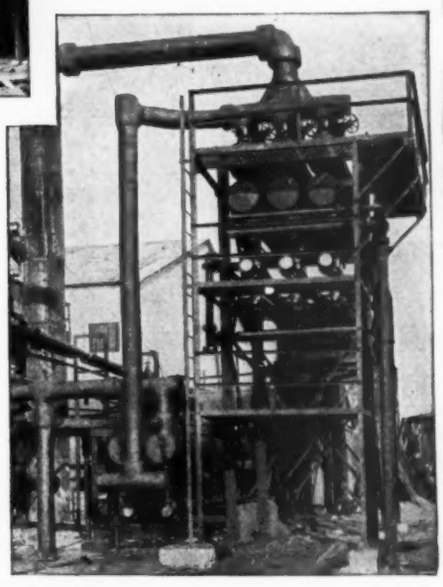
The new factory will be of brick and steel construction with the front of the building of white stucco. The company's Tulsa offices will be moved from the Kennedy Building to the new plant upon its completion, so that a direct tie-up between factory and offices can be maintained at all times. No expense is to be spared in completely equipping the new building. The grounds are to be beautifully landscaped and the whole property and building will be floodlighted at night.

GASOLINE PLANT AND REFINERY

HEAT EXCHANGE EQUIPMENT

TULSA TYPE





WE ARE equipped to build Tulsa Type Exchangers, Condensers and Coolers in any size or capacity, from stock materials, using either Seamless Steel, Aluminum or Admiralty Metal tubes. Large variety of sizes carried for immediate shipment.

TULSA
Boiler & Machinery Co.

TULSA OKLAHOMA

NATURAL GASOLINE PLANTS TANKS REFINING EQUIPMENT

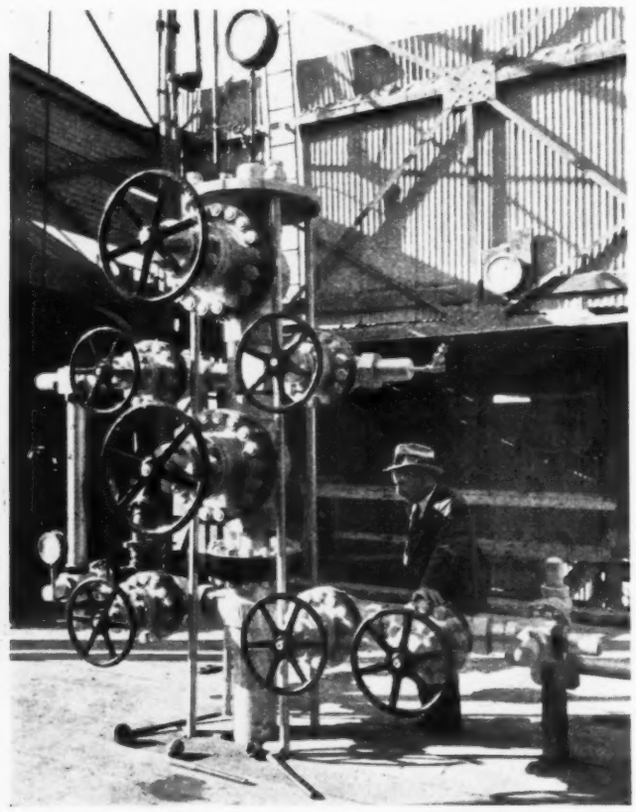
When writing TULSA BOILER & MACHINERY CO. *please mention The Petroleum Engineer*

6000-lb. Pressure Hook-up Developed By Regan

DEVELOPMENT of high pressure heads for service at Kettleman Hills has resulted in the manufacture of equipment that is meeting all requirements of safety in this field, according to operating officials.

When the first high pressure at Kettleman Hills was tapped the engineers of Regan Forge & Engineering Co. had already developed extra heavy equipment, anticipating such pressure, and are now producing a complete line of extra heavy equipment supplementing the standard pressure types.

The illustration shows a typical hook-up of the high pressure Regan tubing head at Kettleman Hills with Christmas Tree and fittings tested as a unit to 6,000 lbs. pressure. In



order to effect a positive test of pressure, Regan engineers have found it advisable to test all high pressure equipment assembled before shipment from the factory, applying 6,000 lbs. pressure to the assembly rather than to the parts only.

The hook-up shown in the photograph is one of several developed by Regan for Kettleman Hills service. The riser is 9½" O. D., extra heavy hydraulic tubing, with walls ⅞" thick. This heavy-weight pipe connects the top flange of the casing head in the cellar to the high pressure tubing head shown in the photograph.

The flanges of the casinghead are drilled and the studs and bolts are to the AESC standard high pressure series. Four-way crosses, 6⅝" by 4" in size are of extra heavy design, suitable for pressures far in excess of 6,000 lbs. The casinghead ties and suspends a 16" surface string, an 11" second string and an 8⅝" oil string.

The size of tubing head is 9", forged steel with male outlets, and is equipped with a combination metallic and hydraulic packing, a recent development by Regan to offer a wide factor of safety against extremely high pressure and fire. The studs are made of alloy steel. Two 6⅝" and five 4½" 6,000-lb. test valves complete the hook-up. A plate flange is set at the top of the Christmas tree for connection with bolted trusses which extend to the landing flange below the casinghead, offering very rigid support.

May Develop Cracking Operations

POSSIBILITIES of fitting oil cracking operations into the manufacture of illuminating gas, as well as motor fuel, appear to be developing not only in this country, but abroad.

This is indicated by recent visits of two distinguished foreign technologists to the offices and laboratories of the Universal Oil Products Company at Chicago, according to Paul Truesdell of that company.

One of these visitors is Professor E. F. Armstrong, a director of the South Metropolitan Gas Company of London, and the other is Professor Walter Muller, head of the Engineering Economics Department of the University of Chile at Santiago, and also chief engineer of the leading gas company of Chile.

Both these men are studying the possibilities of using cracking equipment to make high-grade motor fuel on one hand and at the same time enrich manufactured gas through the utilization of the fixed gases from the cracking stills.

Heat Transfer Pamphlet

Bulletin 1651—Heat Transfer Apparatus—by the Griscom-Russell Company, New York City, is an illustrated pamphlet showing the construction and installation of heat exchanges in oil refineries and gasoline plants. It also contains valuable curves and data for figuring heat transfer problems.

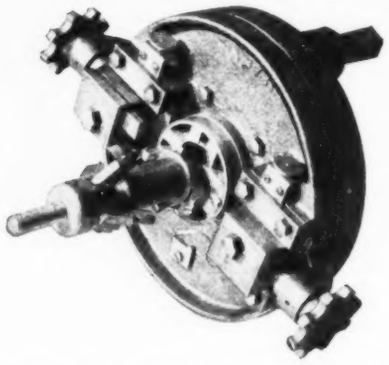
Liquidometer Catalogue

The Liquidometer Corporation, Long Island City, New York, has mailed out an illustrated pamphlet describing the Liquidometer for distance reading of tank gauges. The Liquidometer accurately indicates the tank contents gauge and requires no manual operation.

Diamond Alkali Handbook

The Diamond Alkali Company, Pittsburgh, Pa., is distributing a valuable booklet containing tables and charts showing the properties of caustic soda, soda ash, bicarbonate of soda and chlorine. Methods of chemical analysis for these products are given.

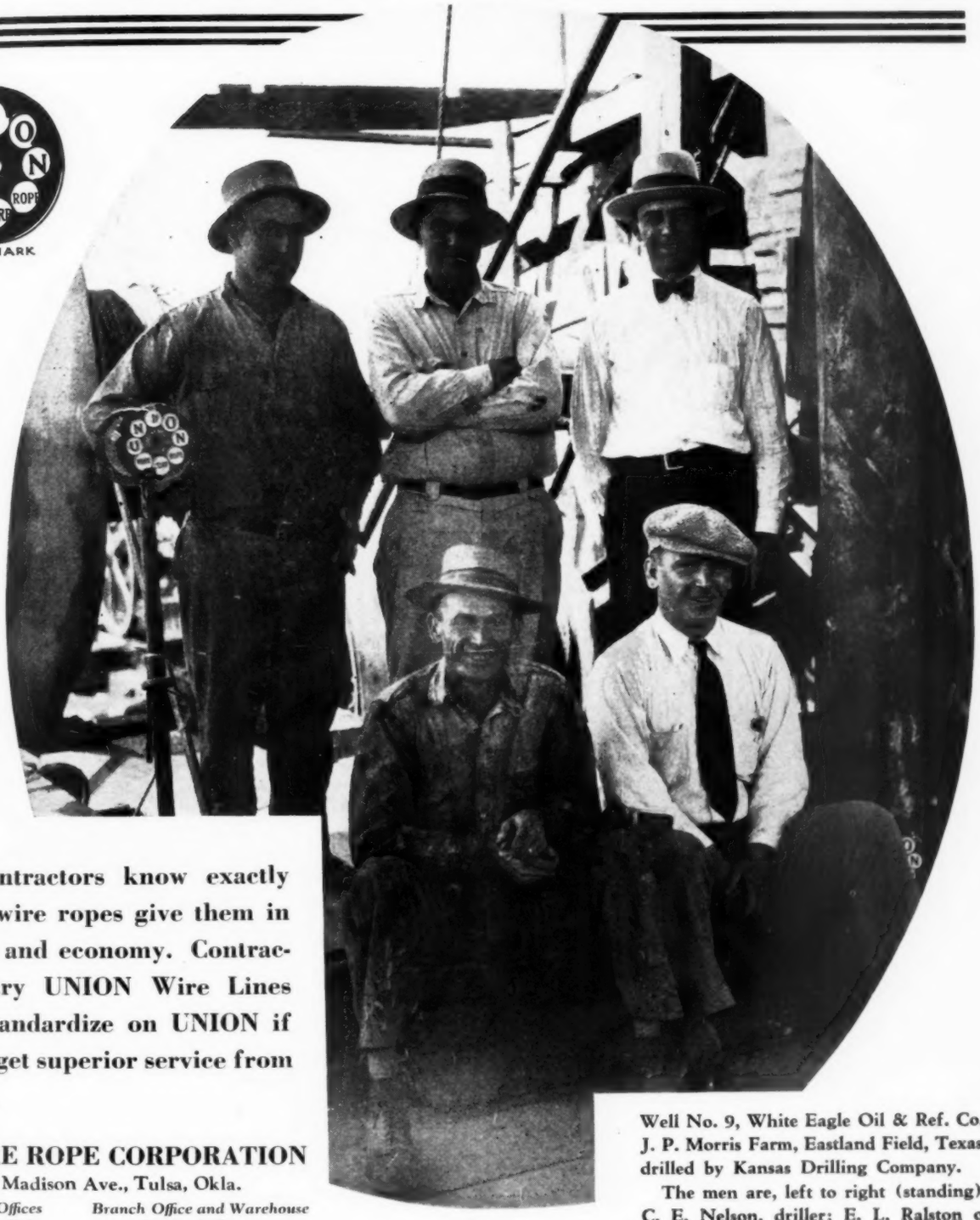
Beaver Tool For Victaulic Joints



The accompanying illustration shows the No. 20 Beaver Grooving Tool, which is specially designed for Victaulic Couplings. Bulletin "G" describing the operation of this tool has been distributed by the Borden Company, Warren, Ohio.

CONTRACTORS..... *KNOW THE ROPES*

UNION WIRE ROPE CORE
TRADE MARK



Drilling contractors know exactly what their wire ropes give them in satisfaction and economy. Contractors who try UNION Wire Lines wouldn't standardize on UNION if they didn't get superior service from these lines.

UNION WIRE ROPE CORPORATION
3 North Madison Ave., Tulsa, Okla.

Oil Country Sales Offices
338 Kennedy Bldg., Tulsa

Branch Office and Warehouse
Portland, Oregon

Factory: 21st and Manchester, Kansas City

JARECKI MANUFACTURING COMPANY
Oil Country Distributors — Stocks at All Stores

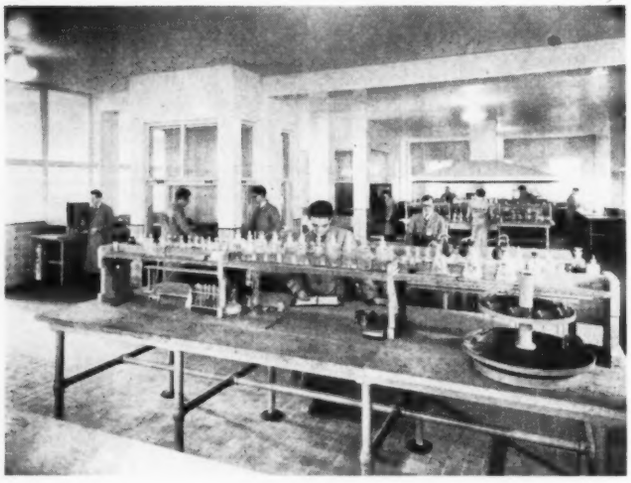
Well No. 9, White Eagle Oil & Ref. Co., J. P. Morris Farm, Eastland Field, Texas; drilled by Kansas Drilling Company.

The men are, left to right (standing): C. E. Nelson, driller; E. L. Ralston of Kansas Drilling Company; J. R. Custer, Mgr., of Jarecki Store, Coleman, Texas. (Sitting): L. J. Norris, tool dresser; H. G. Alston, Union Wire Rope Corp.

UNION WIRE LINES

When writing UNION WIRE ROPE CORPORATION *please mention The Petroleum Engineer*

Dearborn Chemical Has New Laboratory



THE Dearborn Chemical Company, Chicago, Ill., was founded in 1887. It was conceived by a pioneer and in its inception involved a great idea: Recognition of the necessity for chemical analysis of water before attempting to correct troubles arising from the impurities in the water.

The Laboratory staff devotes its time principally to water analysis and research. The men have come to us from the Armour Institute, the Universities of Wyoming, Illinois, Ohio State, Oregon, Chicago, Mississippi, Iowa, Purdue and many other schools of high rating.

The new laboratory is complete in itself—it occupies an entire second floor of Building No. 2 and comprises a main laboratory, eight smaller private or classified laboratory rooms, a receiving room, storeroom, three offices and a library.

The main laboratory is a room approximately fifty by one hundred feet. Its walls are tiled from floor to ceiling in two shades of green—the ceiling is cement plastered and painted —as is all the wood work, in a cream color covered with a fume-proof enamel or varnish. The floors are of a terra cotta vitreous tile. There are eight single working tables, in addition to those that line the walls. These are all alberene stone topped. The table for volumetric work is lighted above and below by daylight lamps—in the latter case through frosted glass insets in the table top. A huge enameled metal case fills about one-third of one of the long wall spaces for storing chemicals and glassware. The tables devoted to the work of water analysis are covered with individual hoods which are tied into a ventilating system.

The eight smaller rooms are equipped especially for coal analysis, oil testing, factory control work, bacteriological examinations and special research. There are two balance rooms — one for the routine group and one for the research men.

In one of the research rooms is a small experimental boiler capable of operation up to 500 pounds pressure from which samples can be removed and into which water and chemicals can be forced at any time. It is heated by horizontal electrical elements similar in location to boiler tubes. These small laboratories, which can be shut off from the main laboratory, have their own separate ventilation system.

Lucey Now Handles Wickwire Spencer

The Lucey Products Corporation is now the agent for Wickwire Spencer Wire Rope in the Oklahoma territory, carrying stocks at Maud, Oklahoma City, Tulsa and Duncan.

New Specification Sheet by Metric

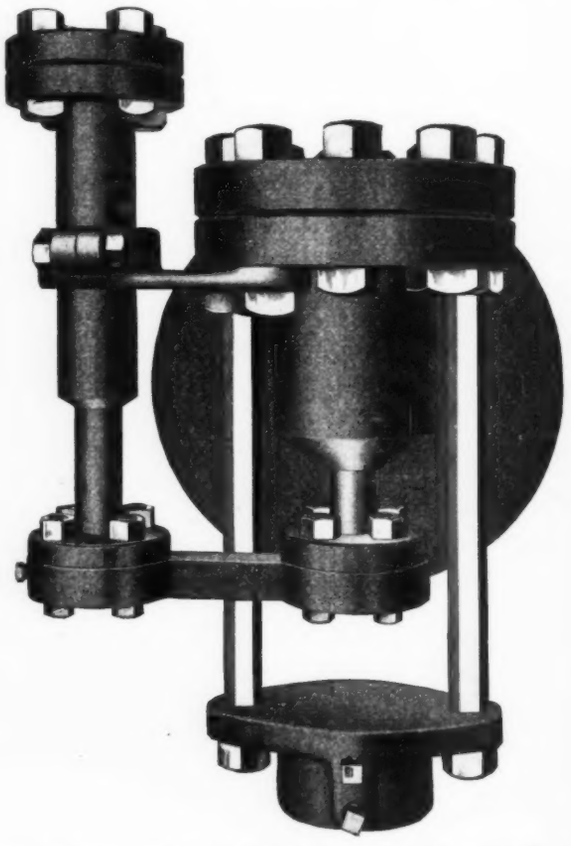
METRIC METAL WORKS, of American Meter Company, Inc., has issued a new specification sheet covering all sizes of iron case meters from 5B to 500B, inclusive. This sheet shows maximum working pressures, type and size of connections, low pressure capacities and recommended maximum hourly rates for high pressure measurement. It also gives complete data on the dimensions of top and side connections.

A High Pressure Meter by Foxboro

THE increasing use of high pressures for boilers and for process work has led to the development of a new flow meter guaranteed to stand a working pressure of 0 to 5,000 pounds per square inch. It has been built for measuring the flow of gas, air, steam, hot oil and gasoline.

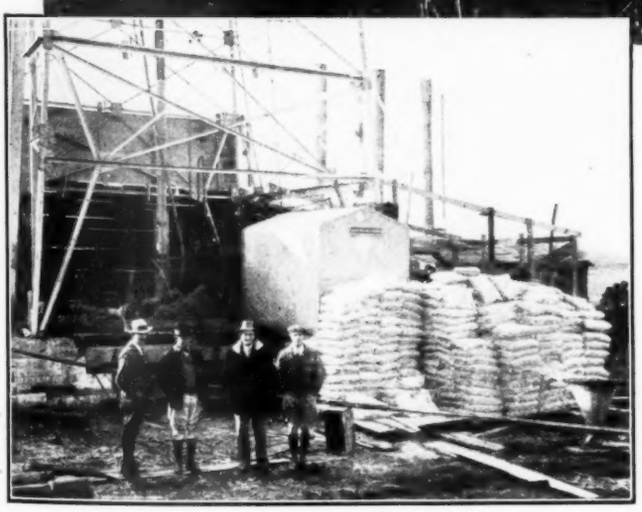
While retaining all the excellent features that have made Foxboro Orifice Meters so well known, the pressure chambers of this new meter have been so constructed as to meet the higher pressures with absolute safety. A glance at the accompanying illustration will show the sturdy construction of this meter. All working parts subjected to pressure are drop forgings, and every part is specially designed for high pressure work.

All known errors and variables have been eliminated, and the new meter has no unknown quantities and no inherent defects. It is calibrated to read and record in terms of flow and may be equipped with an integrator that reads direct without multipliers the total flow in gallons or feet or pounds.



The combination of four great factors — accurate coefficients, a differential measuring device that is inherently accurate, an integrator that can be depended upon, and pressure chambers that will meet any commercial condition —results in a high pressure meter of extreme simplicity and accuracy.

Prestolith VELO CEMENT



S. Bright No. 5. Prestolith Velo Cement used. Halliburton Process

ask the men in the field!

Prestolith Velo 24-hour cement is an improved Portland cement which meets all the exacting requirements of speed, high strength, plasticity, water tightness, durability, and safety imposed on it by the oil trade.

The S. Bright No. 5, Sedgwick County, Kan., owned by L. H. Wentz, is one of the many wells where Prestolith Velo has meant a considerable savings to the owners.

Write for complete information.

MISSOURI PORTLAND CEMENT CO.

ST. LOUIS KANSAS CITY MEMPHIS

Manufacturers of "Red Ring" Portland Cement and "Prestolith" brand of Velo Cement. Producers of sand, gravel and Bethany Falls crushed stone.

396

When writing MISSOURI PORTLAND CEMENT CO. *please mention The Petroleum Engineer*

The Alco Underreamer

THE new underreamer manufactured by the Alco Oil Tool Co., Inc., represents a distinct departure from the usual design of these tools. The principal points of difference are in the method employed for expanding and releasing the roller cutters and in the arrangement of the cutters themselves.

As shown in the illustration, there are three sets of rollers, all of which rotate on eccentric bushings mounted on the mandrel. The middle set of three rollers is held at all times in an off-center position by the bushing being keyed to the mandrel. The position of the top and bottom sets of rollers, for expansion or release, is controlled by specially designed latches which are operated by the rotary motion of the tool.

When not in operation, or when rotated to the left to withdraw from the hole, the three sets of rollers take a closed position that allows ample clearance to pass the tool through the casing. When the underreamer is rotated to the right, as in operation, the top and bottom sets of cutters move outward to an eccentric position diametrically opposite to that of the center set, and are held there by the latches as long as the tool is in operation.

These latches are so constructed that the underreamer cannot fail to release or expand at any desired point in the hole, the rollers expanding and setting positively when the tool is rotated to the right and releasing quickly and freely when rotated to the left. Action and operation is dependent on no other agency than the mechanism of the tool itself. Due to the arrangement of the cutters, the hole is always reamed to full gauge; when the reamer is run into the hole again after being withdrawn, reaming begins exactly where it was left off. With the long reaming surface, which averages five to six times the diameter of the hole, the reamer cuts faster and operates longer in the hole before it must be withdrawn. Another important feature is that the tool is designed to leave a large space free for the circulating mud, making it almost impossible to ball up the reamer in any formation.

The Alco Oil Tool Co., Inc., P. O. Box "A", Compton, Cal., will be glad to furnish any further information regarding this underreamer, and their engineering department will be glad to co-operate to the fullest extent in solving any specific underreaming problem that may come up.

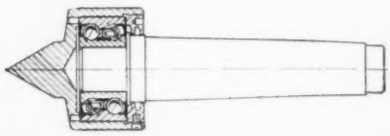
Quasi-Arc Products Demonstrated

BEFORE an interested group of pipe line contractors and welding officials of transporting companies, Quasi-Arc Incorporated, New York, recently demonstrated at Tulsa, Oklahoma, its uranium electrodes and multiple welding machine. The machine was made especially in accordance with Quasi-Arc specifications for the demonstrations.

It is a portable gasoline engine driven, four welder set, and the generator is a 25 KW 50 full load and 40 no load D C. volt machine. In circuit with each welding arc a special L type inductive resistor provides the necessary reactance, and an L type current regulator for current adjustment. The former stabilizes the arc, and generally renders the operation of welding simple for a moderately skilled operator. The regulators give a range of amperes from 25 to 200 in 12 stops and are easily handled by one man.

New Work Centering Device

THE greatly increased speeds at which metal removing machines now operate, in order to take full advantage of the new cutting tool materials, have practically necessitated the use of anti-friction bearings in the work centering devices of many types of machines.



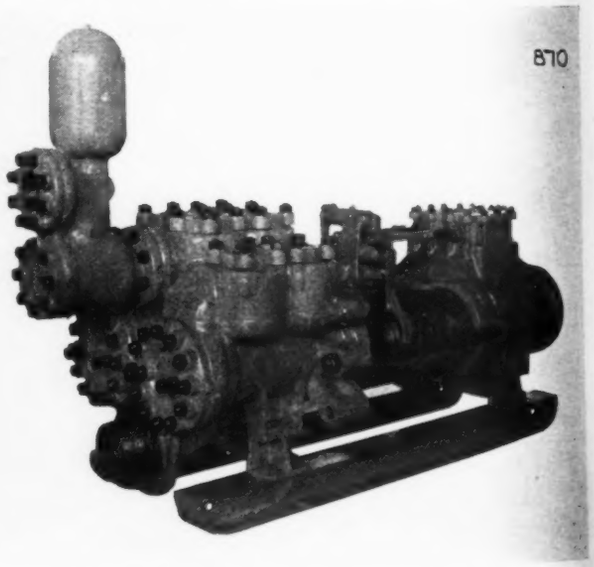
The ball bearing equipped tailstock live center placed on the market by the Ready Tool Company of Bridgeport, Connecticut, has met all of the requirements of such a device with especially fine results. It is recognized that the edges of cutting tools made of the new high speed materials are very sensitive to any chatter or vibration and the success of this live center is due to the extremely rigid and non-deflecting support which it provides for the work.

This rigid and extremely accurate support under all load and speed conditions is made possible by the design of the New Departure Double Row bearing employed. This angular contact bearing has solid, high carbon chrome steel inner and outer races and is so assembled that the two rows of balls are opposed in a definitely preloaded condition. It has been thoroughly demonstrated that when work is supported by this bearing not only is chatter reduced and cleaner cutting obtained, but the edges of cutting tools stand up much longer than is the case with dead centers which cannot be tightly adjusted to the work.

Small Slush Pump by Lucey

LUCEY PRODUCTS CORP. has designed a small slush pump to take care of the heavy pressures in territories where the big heavy duty pumps are not needed. This pump has many of the features that have made the large Lucey pumps so popular, including short direct fluid passages, oversize piston rods, steel tie rods, forged steel liners and sled type steel skids.

The water end is hydrostatically tested to 2,000 pounds both in suction and discharge and is equipped with bevel type valves and seats. The water valves have forged steel bodies and a 2" stem which extends below the insert. The



steel crowfeet are threaded and fitted with heavy castellations and serve as nuts to retain the insert. The steam end is of extra heavy construction to stand extreme steam pressures and is equipped with balanced slide valves.

"B
RO
BI
"a Bi ahead"
(Licensed Under Powell Patents Pending)
85 feet of hole in 15½ hours using one set of cones in exactly the same formation and depth as competitive rock bit drilled 84 feet in 88 hours using 11 sets of cones.
THE above is only one of the many records of the BJ Rock Bit in service. It was made in a well at Santa Fe Springs under ordinary operating conditions ◆ Test after test in actual service proves that the BJ Rock Bit makes many times more hole, under identical conditions, than any other rock bit ◆ Write us immediately for other detailed performance records and details of the BJ *Gear-Driven, Self-Sharpening* Rock Bit ◆ They are startling ... convincing ... evidence of BJ supremacy in any kind of drilling.
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Some Properties of Mid-Continent Crude*

OGDEN FITZSIMONS† *and* W. H. BAHLKE†

Introduction

In many of the calculations necessary for the design of refinery equipment, the molecular weight of the substances under consideration is involved. The usual data available for the solution of a problem consist largely of data on such properties as A. S. T. M. distillations, gravity and viscosity. Correlation of these more easily determined physical properties and molecular weight would permit placing many of the calculations on a more certain basis. This paper presents a correlation between molecular weights and several properties of Mid-Continent crude and fractions thereof.

Experimental

The data were obtained by determining the gravity, viscosity, A. S. T. M. distillations, and molecular weights on fractionated cuts from Mid-Continent crude. Some of the data were obtained from measurements on fractions prepared by laboratory fractional distillations, while others were obtained on refinery streams. The crude in all cases was an average Mid-Continent pipe line crude as received at Whiting.

To prepare the laboratory cuts, two gallons of crude were slowly distilled through an insulated Hempel column 2 ft. high, packed with ⅛ in. diameter Rashig ring. Heat was supplied to the column electrically, so that the tower top temperature lagged the still temperature by not more than 100 deg. F. When the still temperature reached 540 deg. F., about a 5 mm. vacuum was applied and the distillation continued so that 70 per cent was obtained as distillate without heating the oil higher than 540 deg. F. During the vacuum distillation, the tower top and still temperature differential was maintained at 100 deg. F. At the start of the atmospheric pressure distillation, the condenser was cooled with carbon dioxide snow in alcohol to minimize gas losses. Fractions representing 2½ per cent of the crude were taken throughout the distillation.

Portions of the wax bearing distillates were dewaxed at —15 deg. F. in 30 per cent naphtha solution, and the naphtha subsequently removed.

Gravity, viscosity, and A. S. T. M. distillations were obtained by the usual methods, checks being made in most cases. Molecular weights were determined in general by the cryoscopic method, although cross checks were made in some cases using the Victor Meyer vapor density and Menzies-Wright boiling point rise methods.[1]

In the cryoscopic method of Beckmann, chemically pure benzol, dried over sodium, was thrice crystallized and used as solvent. Its freezing point was 5.45 deg. C. In all cases the substance under investigation was weighed on an analytical balance. Determinations were made at several molal concentrations varying between 0.5 and 7 per cent. At each concentration, several determinations were made at various degrees of super-cooling. Corrections were applied for the change in concentration due to crystallization of benzol and for the change in apparent molecular weight with change in concentration due to association.

Some comparative values of determined molecular weight are shown in Table I.

TABLE I

Comparison of Molecular Weights by Various Methods

Sample No.	A. P. I. Gravity	Molecular Weight: Cryoscopic Method	Molecular Weight: Menzies Method	Molecular Weight: Victor Meyer Method
1	88.2	74.5	.....	72.5
2	74.8	87.0	.....	88.9
4	65.0	96.3	.....	95.7
7	55.4	113.8	.....	113.3
10	49.1	131.0	.....	127.8
124	30.5	284.6	297	.....
127	27.9	340.0	357	.....
106	57.8	108.9	.....	106.5
				112.5
130	24.3	416.0	422	.....

Results

The correlation between molecular weight and other properties is shown in Fig. 1 to 7.

Fig. 1 shows the relationship between A. P. I. gravity and molecular weight. It is noteworthy that the molecular

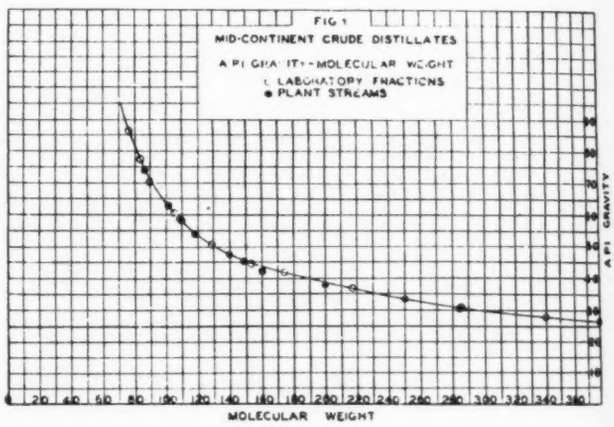

FIG. 1

weight-gravity relationship for the crude (molecular weight 209, gravity 36.6 A. P. I.) is nearly identical with the relationship for the narrow cuts.

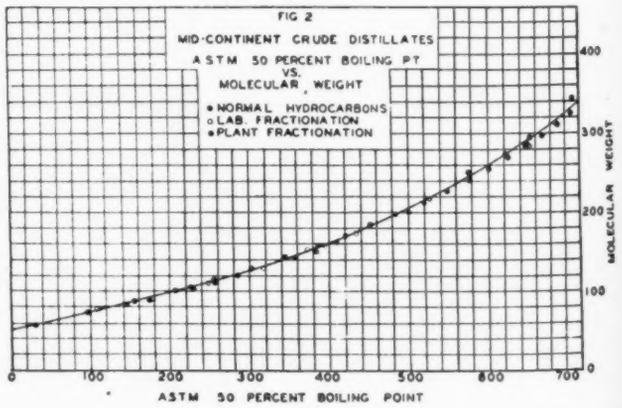

FIG. 2

Fig. 2 shows the relationship between A. S. T. M. 50 per cent point and molecular weight.

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* Paper Delivered at Tenth Annual Meeting, American Petroleum Institute, Chicago, Ill., December 5, 1929.

† Standard Oil Co. (Indiana), Whiting, Ind.

[1] J. Amer. Chem. Soc., vol. 43, 2314 (1921).

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Fig. 3 shows the relationship between reciprocal molecular weight and weight per cent for narrow cuts. For wide cuts the molecular weight must be obtained from Fig. 4 (mol per cent versus weight per cent) which is an integral curve of Fig. 3. Its use is illustrated by the following example. A distillate is obtained representing 20 to 40 per cent off of the crude. From the plot, the total mols distilled up to 20 per cent gives 0.196 and up to 40 per cent as 0.324 mols. Then the molecular weight is $\frac{40-20}{.324-.196} = 156$. This curve loses its accuracy beyond 70 per cent, but fortunately Fig. 3 gives nearly linear relationship beyond 50 per cent so the molecular weight can be obtained by its use and the mean weight per cent of the cut. A volume per cent-weight per cent plot is incorporated in Fig. 4, so this plot may be of use when percentage is expressed on a volume basis.

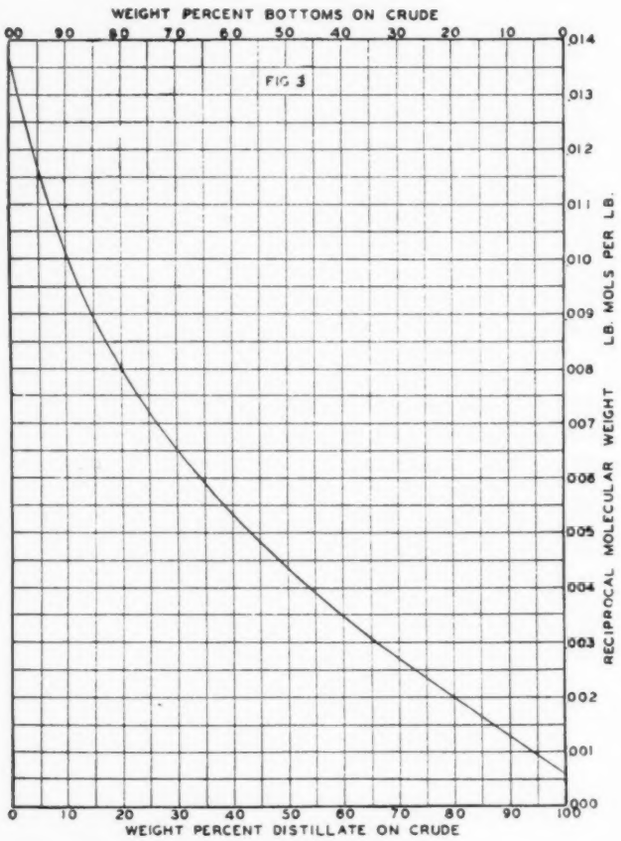

FIG. 3

The relationship between total volume per cent distillate and molecular weight and volume per cent bottoms and molecular weight, shown in Figs. 5 and 6 were obtained from Fig. 4, and are of interest as showing the change in total molecular weights as distillation proceeds.

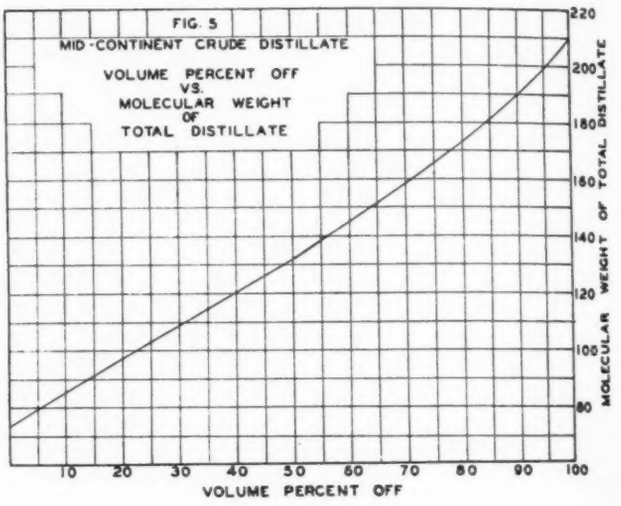

FIG. 5

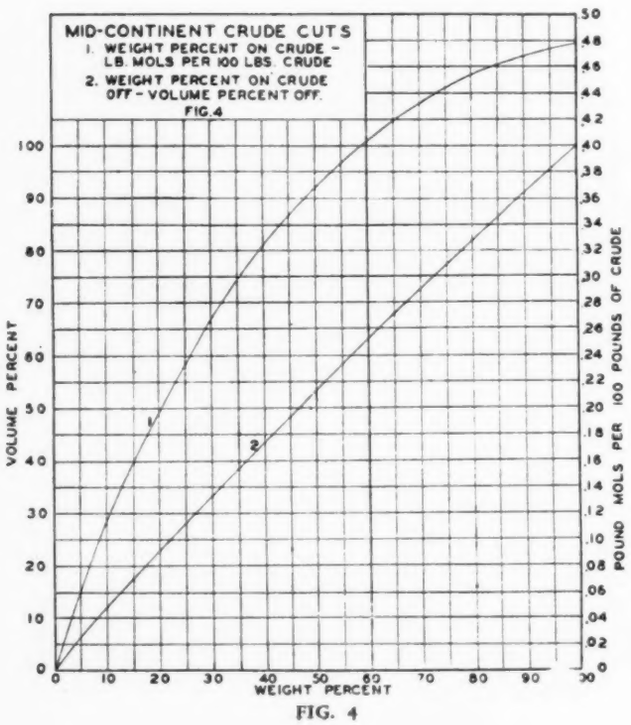
MID-CONTINENT CRUDE CUTS
1. WEIGHT PERCENT ON CRUDE - LB. MOLS PER 100 LBS. CRUDE
2. WEIGHT PERCENT ON CRUDE OFF - VOLUME PERCENT OFF.
FIG.4
VOLUME PERCENT
POUND MOLS PER 100 POUNDS OF CRUDE
WEIGHT PERCENT

FIG. 4

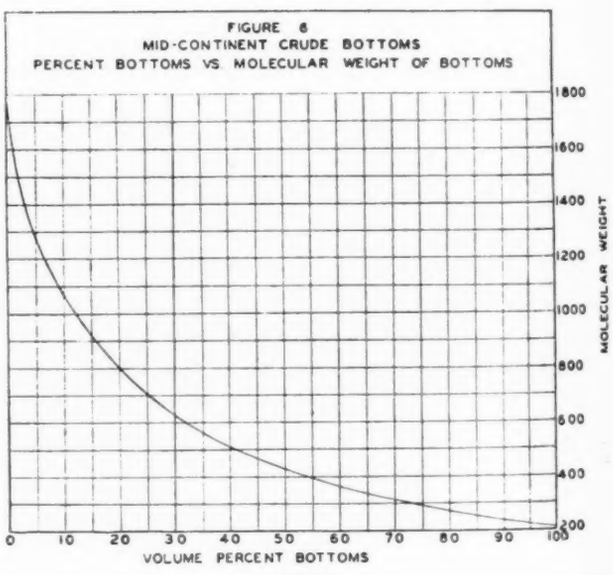

FIG. 6

Fig. 7 shows the relationship between Saybolt universal viscosity at 100 deg. F. and molecular weight. Fig. 8 shows the relationship between absolute viscosity at 100 deg. F. and molecular weight.

Fig. 9 shows the relationship between total volume per cent distillate and bottoms and specific gravity.

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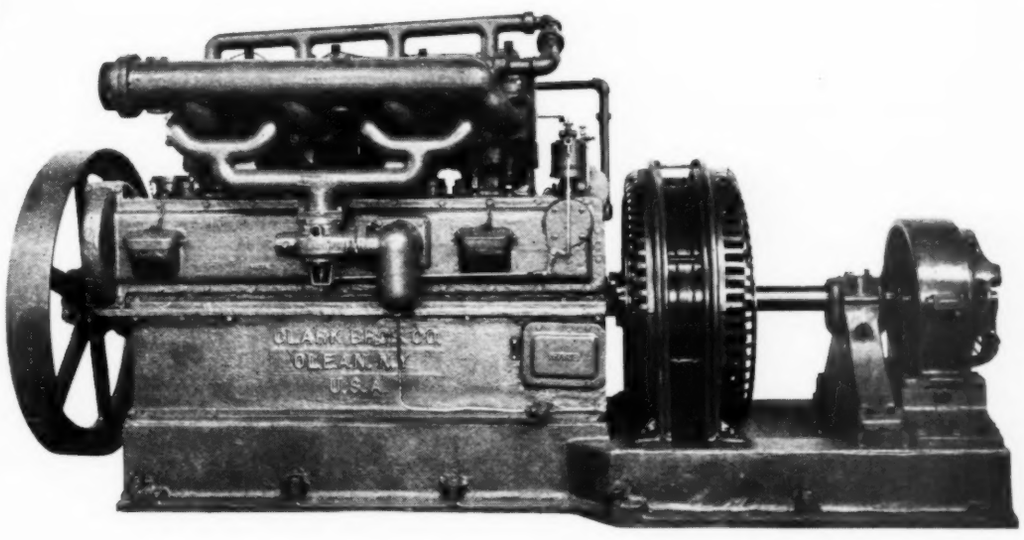

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Other combinations, useful for some purposes, could be shown, but it is believed that the data presented here are sufficient to enable those desiring such other combinations to prepare plots.

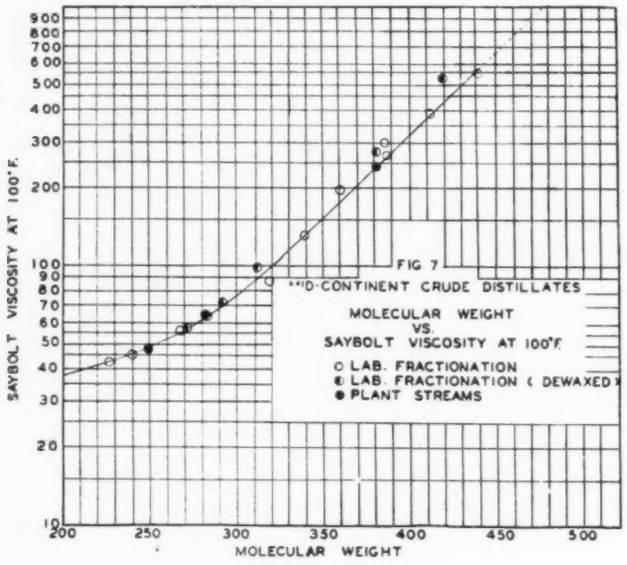


FIG. 7

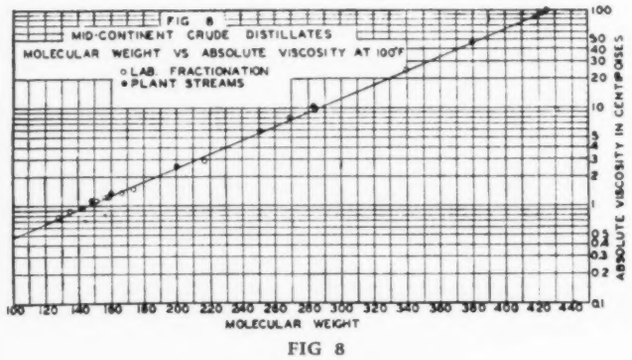


FIG 8

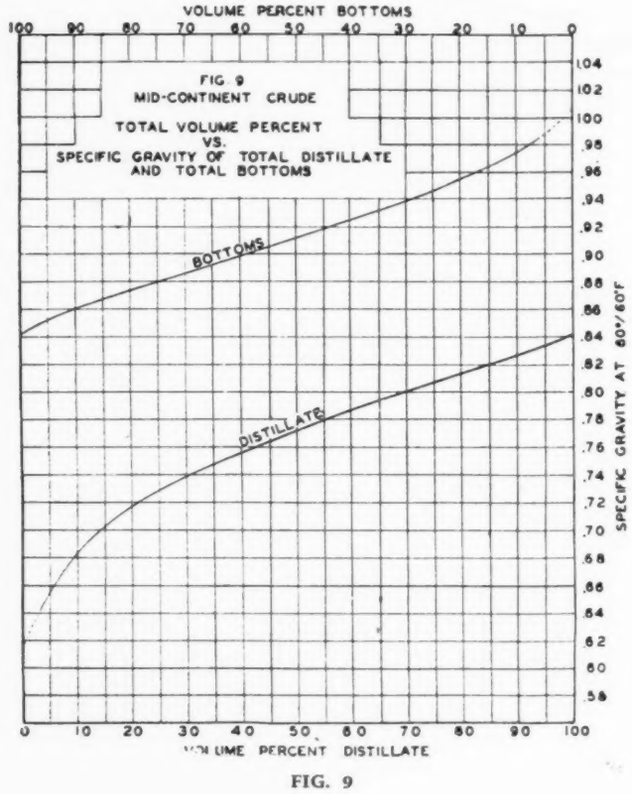


FIG. 9

R. R. Brandenthaler Victim of Explosion

RUDOLPH RICHARD BRANDENTHALER, well-known petroleum engineer of the United States Bureau of Mines, lost his life in an accident at the Petroleum Experiment Station, Bartlesville, Oklahoma, on the evening of December 13, 1929, when part of an experimental rig equipment exploded. In the fire which followed, Meredith Miles, Junior Engineer, sustained severe burns from which he died within a few hours. Gustav Wade, Dynamometer Engineer, and Robert E. Holt, Mechanic, suffered from minor burns.

Mr. Brandenthaler was born in Milwaukee, Wisconsin, April 28, 1890. Losing both his parents early in life, he

R. R. Brandenthaler

went to work at 12 years of age after he had completed his grammar school education at Seattle, Washington. He did not enter high school until the age of 19. Graduating from high school he attended the University of Washington, Seattle, for three years as a student in Geology and Mining. During these three years, 1913 to 1916, his summer vacations were spent working in the mines of Alaska. He then left the University to engage in mining work in Juneau and Douglas, Alaska. From Douglas he went to Windy Arm District, Yukon, where he was successively Assayer, Engineer, and Superintendent of Concentrator. At Mineral Lake, Prince of Wales Island, Alaska, he supervised construction of a 50-ton concentrator. He enlisted for service in the World War, January 5, 1918, and was discharged July, 1919, after having seen service overseas. On his return from the war he spent nine months in hospital recovering from the effects of gas and shell-shock. In the fall of 1919 he re-entered the University of Washington and continued his studies for two years, receiving his B. S. in Mining and Geology, in addition to completing almost all required post-graduate work toward a Master's degree. After a short period in Alaska in the fall of 1921 in the Government Coal Fields he returned to the United States and became Engineer for the Sunset Copper Company at Index, Washington. He taught chemistry in high school at Bellingham, Washington. Here he met Lenore Thomas, whom he married later at Fresno, California, in January, 1923. She, with an adopted son, Richard, survives him.

Insects Cause

Destruction of Derrick Foundations

IN Rogers' Natural History the Teredo is described in part, thusly: Genus Teredo, navilis, Shell bivalve, globular, small; valves three-lobed, gaping with interior spoon-shaped process from hinge; animal worm like in shelly burrow with two long siphons united almost to the ends, tipped with shelly pallets, orifices fringed. A ship worm.

What he or she, depending on the gender a Cajun is likely to call it, is called by the group carrying on the development of The Texas Co.'s marine salt dome development in Terrebone parish, coastal Louisiana, is unwise to publish. However, it is a-plenty.

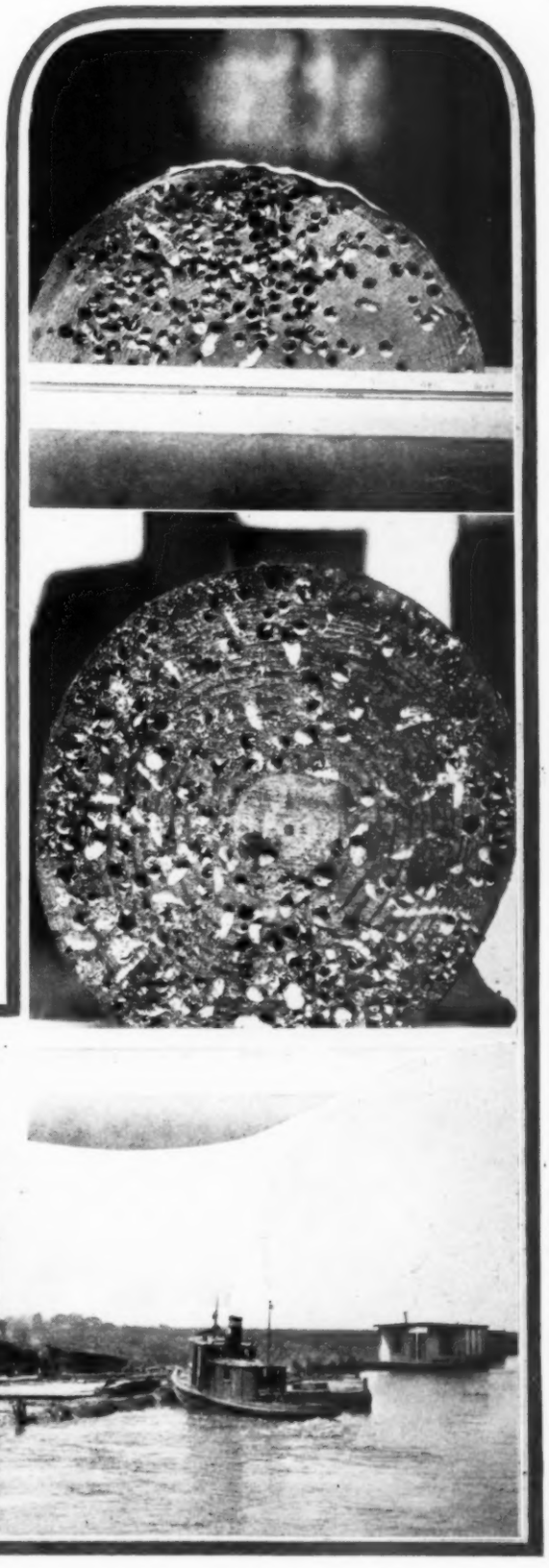
The teredo is a serious problem to the producing company as is graphically shown by the damage it has caused to the pilings illustrated in the accompanying photographs. With several domes in that part of the coast to be developed, all of which are under water, it is probable the producing company will drill several hundred wells. Present indications lead to the belief that the greater portion of these wells will go down in the open water and only a few will be drilled in the marshes.

Each location requires the driving of 300 or more pilings for the derrick, pumps, engine, slush and mud pits, water and fuel tanks, tool and boiler houses and walks. This number of pilings give a foundation approximately four times stronger than required on the basis of crush tests of the piling. But in seven months' time the teredo has burrowed into the piling and reduced its strength approximately 50 per cent. All of the piling used thus far has been natural wood which will be changed when new foundation specifications are made.

In Terrebone parish the teredo has confined its attack to only those derrick piling located in brackish water. So far no evidence of its attacks have been found in piling located in pure salt water, in that region. It attacks between the mud line and water line and apparently works both directions. One of its characteristics is that the tiny hole it makes to enter is never enlarged though the burrow is widened as it lengthens behind it.

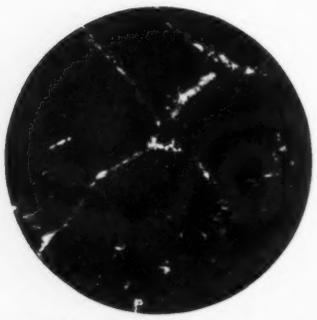
The seriousness of the problem is gained from the number of 60-foot piling that are sunk until they stand 15 feet above the water. Fifty-six are required for the derrick, 69 for the slush pit and reserve mud pit and 50 for the water and fuel tanks. The minimum number used thus far is 300 and the average is somewhere around 350. Whenever a well is abandoned the piling must be pulled to conform to Federal Government requirements in that area.

Some writers have a good word for the teredo because it clears harbors of hidden dangers to navigation when such dangers are wood and because it is the scavenger of the sea coasts. But, in the language of a foreman, "who cares about that?"



Two views showing what the Teredo's appetite can do to piling. Below, a typical drilling location in South Louisiana.

The "Inside Difference" between JONES *fully normalized, high manganese steel* SUCKER RODS and ordinary rods, as revealed by the m[illegible]scope



Under the microscope, most sucker rods show a highly varying grain structure.

Micrograph of the body of an ordinary rod. Compare this with the one below.

Pictures tell the story an[illegible]he "Jones" story in full.

An ordinary sucker roc[illegible]the microscope, shows an utter lack of unifo[illegible]n structure,—different parts of the same rod a[illegible]ed as having an entirely different metallurgical[illegible]. . . Therein lies the secret of the superior[illegible]nes High Manganese Steel Sucker Rods.

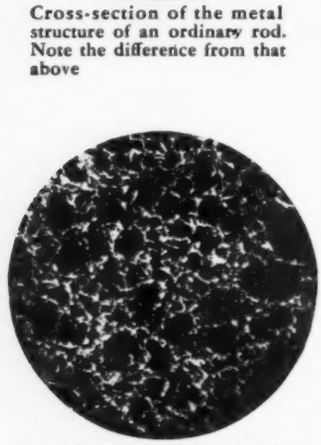
Any Jones Rod, put to [illegible]roscope test, will show a perfect, uniform grai[illegible]re from end to end,—hence their high fatigue[illegible]ce, lack of heat demarcation and unequalled rec[illegible]tisfactory performance.

Jones Fully Normalized[illegible]anganese Rods are the *only* sucker rods that a[illegible]actured under full heat treatment,—the entire l[illegible]each rod is heat treated at the same time, unde[illegible]m temperature, in the world's largest sucker[illegible]rmalizing furnace . . . They are the *only* r[illegible]s the uniform grain structure test,—Ther[illegible]e the *best* rods to use.

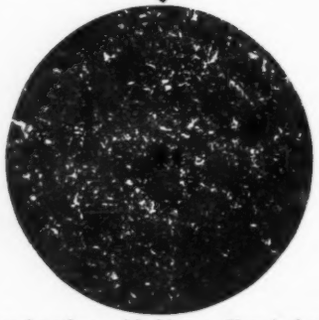
Write for the booklet[illegible]bing this super sucker rod,—every oil man shou[illegible]ave it.

Cross-section of the metal structure of an ordinary rod. Note the difference from that above

Forged end of the same rod with an entirely different grain structure. Note the enlarged crystals.



Another example of poor grain structure in an ordinary rod.



Compare the others with this cut. Here is the "Jones" High Manganese Rod—it shows the same, even, close-grained structure throughout the rod, indicative of its strength and high fatigue resistance.

Ready-for service end of the same rod with a different grain structure from either of the above parts.

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Gasoline Association Adopts Tentative Specifications for

Determining Specific Gravity *of* Gases

THE specific gravity of gases shall be determined by means of a gas balance constructed, as to principle, similar to the Edwards gravity balance described in Technologic Paper No. 89, United States Bureau of Standards. This principle embodies Boyle's law which prescribes that the density of a gas at constant temperature is proportional to its pressure; or restating this law as quoted in the technologic paper referred to, "the densities of two gases at normal pressures are in inverse ratio to the pressures when of equal buoyant force."

A. Apparatus

1. *Balance.* The balance to be used shall consist essentially of a balance beam with its supporting fulcrum mounted inside a gas-tight, cylindrical metal case. The balance beam shall have a light, sealed globe, made of a substantially inflexible material, attached rigidly to one end and an adjustable counterweight on the other.

***On December 17th, 1929, the Board of Directors of the Natural Gasoline Association of America adopted a tentative standard for determining gas specific gravities to become effective January 1st, 1930, and thereafter for one year, becoming a permanent standard of the association January 1, 1931, if not otherwise modified or amended before that time by official action of the Board of Directors.*—Editor.**

The beam fulcrum shall be a support, described by the Bureau of Standards as a modified Cardan suspension, as illustrated in figures 1, 2, and 3, and as now further defined. In this construction, four metal strips, fixed rigidly at A (Figs. 1 and 2), are attached securely to parts B which are in reality a part of the balance beam.

The vertical distance between the bottom plane of part A to the top plane of part B shall be between 18 and 20 mm. The distance across the top of B as seen from the side (Fig. 1), shall be the same as the vertical distance between A and B.

The horizontal distance, as seen from the side (Fig. 1), across the lower face of part A where the suspension strips are fastened shall be about 0.1 mm.

Since this suspension acts as though the center of motion is on a horizontal line passing through the bottom of A, as seen in Fig. 2, the center gravity of the beam including the center counterweight G should be on this line. Therefore, the horizontal line H (Fig. 2), passing through the center of the beam should be 2 mm. below the bottom of A.

The suspension strips, C, shall be of phosphor bronze, one-eighth of an inch wide and one thousandth of an inch thick. (If in practice it is found that strips of greater strength are desired, strips 0.0015 inch thick may be used. This should be the maximum thickness.)

A small pin, K, shall be permanently fastened in B at each point where a strip, C, is clamped. Each pin should be approximately perpendicular to the face in which it is fastened and should be located near the lower end of the vertical line passing through the center of the lower plate D. Each of these fastening plates, D, on B, are provided with a hole into which the pin projects. The hole in the plate, D, on the side facing against B should be slightly countersunk in order to allow for any burr which may be around the hole punched in the strip and which otherwise would prevent the plate from pressing uniformly against the strip, C. A small hole shall be punched in each suspension strip, C, several millimeters from the end just large enough so that the strip may easily fit over the pin, K. These pins are for the purpose of holding one end of the suspension strip when it is being mounted. There are no pins in A. The faces of A and B and of the plates, D, which clamp the strips shall be machined flat and smooth so that the strips, C, will be held firmly in place.

The plates, D, shall be held tight by means of two screws each. These screws shall be of such size that they may be turned up quite tightly without danger of stripping the threads or breaking off.

Two spacers of a height equal to the selected vertical distance (18 to 20 mm.) between the lower plane of A and the upper plane of B are to be provided with each balance, with a place to hold them when not in use. These spacers should be in the nature of pins of round cross section and the two should be machined to identical length. The spacers are for the purpose of adjusting the distance between A and B when new strips are being mounted. Sufficient space on A and B to insert these spacers shall be provided at the outside of each set of suspension strips.

Some device, such as that shown in the diagrams, shall be provided for raising the beam approximately 2 mm. and locking the beam securely so that the balance may be safely transported without damage to the mechanism.

The gas-tight, cylindrical case, called the gas chamber, shall be of such dimensions as to easily accommodate the beam mechanism and allow amply for its necessary movement. The sealed globe, or bulb, shall be approximately ellipsoidal in shape with its long axis approximately 20 cm. and its short diameter about 12.5 cm. and should weigh not more than 1.5 lbs. The length of the beam, including the bulb, M, on the one end and the scale, J, on the other should be approximately 48.5 cm.

The sensitivity of the balance shall be, by means of the center counterweight, G, adjustable to such degree as to permit an appreciable displacement of the beam for pressures, expressed in a change of mercury levels, equivalent to 0.500 mm. in each arm of the balance manometer.

The beam scale, attached to the end of the beam, shall be graduated in millimeters and a fine cross hair shall be fixed as a reference in the front head of the gas chamber. The gas chamber shall be equipped with a suitable device for distributing the entering gases in such manner as to prevent any solids or liquid droplets, entrained in the gas, from impinging on any part of the beam mechanism.

It must be recognized that the balance is an apparatus of

high sensitivity and the construction of the mechanism, therefore, must be of highest quality.

The gas balance and all appurtenances used for this test shall be absolutely free from leakage.

2. *Manometer*

The manometer used in determining gas pressures within the gas chamber shall be equipped with scales of thin material graduated in millimeters. The scales shall be mounted in front of the mercury columns and shall extend over the tubes to their centers, thus easily affording accurate readings.

The manometer shall be provided for rigid attachment so that the mercury columns will be perpendicular.

3. *Hand Pump*

As with the balance, it is likewise very essential that the hand pump used for this work shall be entirely free of leaks. Errors likely to result because of leakage in this particular piece of apparatus shall be reduced to a minimum by soldering or tinning all connections. Because of the necessity of operating the hand pump for both vacuum and pressure, the pump shall be equipped with a four-way valve to prevent contamination of gas samples.

4. *Barometer*

The aneroid barometer shall be of reliable manufacture. This instrument shall be checked frequently and adjusted if found to be in error. Barometers shall be calibrated in millimeters.

5. *Balance Mounting*

The balance may be operated from any substantial support free from vibration, in such position that the balance scale may be read with accuracy. In the absence of any other convenient supporting base a tripod should be used for mounting the balance.

6. *Hose and Valves*

All hose used shall be of the thick-wall rubber, pressure-vacuum type and free of any leak.

Only needle valves shall be used on the hose lines. In making the test, it is essential that, as the required pressure is approached, it can be gradually and easily increased or decreased, and the valves used must permit of such adjustments.

7. *Thermometer*

The chamber shall be provided with a ¼" opening (sealed ordinarily with a plug or a valve) into which may be secured and tightly fitted, as required, a thermometer for determining gas temperatures within the chamber.

B. Test Procedure

1. All hose or connections required for the test shall be connected before the test is actually started and the balance shall then be securely mounted and leveled. This precaution must be taken to eliminate, after the test has started, disturbances tending to jar the apparatus and thus introduce errors because of indeterminate changes in the position of the beam.

2. The beam weights shall now be adjusted by trial so that the beam will balance in air at a pressure not greater than atmospheric and in the gas at a pressure not greater than the pressure on the line from which the gas sample is obtained. The utmost care must be taken in adjusting the beam weights. The beam must be secured by the locking device when such adjustments are made so that the beam suspension may in no way be strained or damaged. See that the weights and nuts are tight.

3. The gas chamber and all connections shall now be evacuated to an absolute pressure of not more than 130 mm. of mercury (approximately 600 mm. vacuum), by means of a vacuum pump and with all hose connections closed, the apparatus shall be tested for leakage. Any exact absolute pressure of not more than 130 mm. of mercury shall be maintained, with the apparatus undisturbed, for an interval of not less than two minutes, before the system is adjudged without leaks.

GAS DENSITY BALANCE

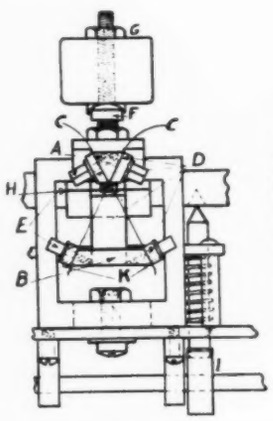


Fig 1

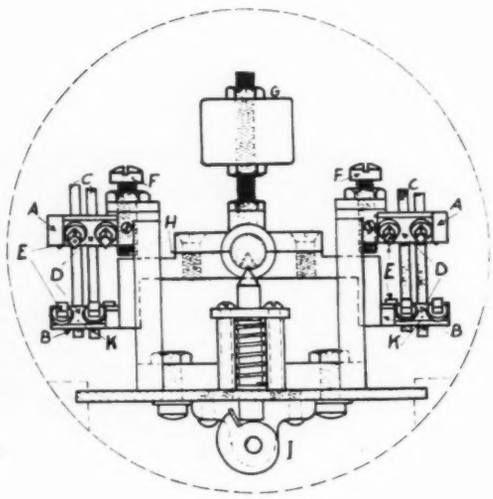
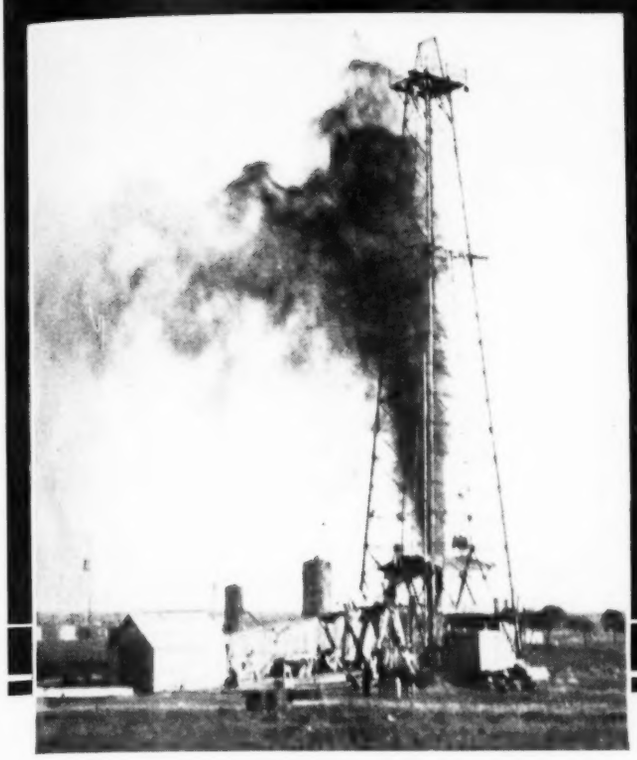


Fig 2

4. The balance shall be evacuated and air allowed to enter at least three times before observing the balance pressure for air. To purge the apparatus the procedure of evacuation by means of a vacuum pump shall be adopted. For each evacuation, the absolute pressure in the balance shall be reduced to within 130 mm. of mercury and the air or gas, as the case may be, shall be allowed to enter at its own pressure. The balance point shall be obtained by operating the valves and not the pump. Sudden surges of air (or gas, when obtaining the balance point in gas) must be avoided. The increase of pressures should be in increments of not more than 0.50 mm. in each arm of the manometer when operating near the balance point. Before reading, the manometer should be lightly tapped with the finger at the mercury surfaces to eliminate mercury sticking to the glass. Record the pressure on the balance, as determined from the manometer, as the balance point for air. Make a check determination to obtain a second reading of the balance pressure. The barometric pressure should be observed and recorded at this time. All barometric readings shall be made with the barometer at rest in the same position throughout the test.

5. Similarly, the balance shall be evacuated and gas allowed to enter at least three times before the balance pressure of the gas is obtained. The manipulations described above in Paragraph 4 shall be repeated for obtaining the balance point in gas. Two determinations of the gas balancing pressure shall be made.

"WHEREVER THERE'S OIL"



I. T. I. O. and Foster Petroleum Co.'s Thomas-Fuzzell No. 1, the largest well in the history of Oklahoma. Drilled by Mandeville & Thompson. Total depth 6,542 feet.

Wofford Drilling Co., Atlantic Oil Producing Co. and R. A. Irwin's McGee No. 1. A 2,200-barrel wildcat N. W. of the St. Louis, Okla. Pool. Total depth 3,875 feet.

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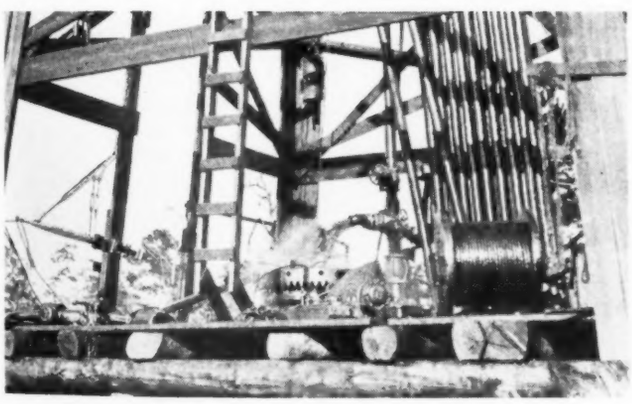

R. L. Gay's Bowman-Hicks A 1. A 20,000-barrel extension to the Zwolle, La., Pool. Total depth 2,413 feet.

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6. Finally, before dismantling the apparatus, the balance shall be purged a third time by evacuation, as instructed in Paragraph 4, for air, and the balance pressure in air again obtained and recorded. The barometric pressure shall again be observed at this time.

7. See that the beam mechanism is secured by the locking device after the test is completed.

C. Notes

1. The accuracy of the test shall be such that check determinations of the gas specific gravity will agree within two units in the second decimal place for wet gases, or gases having a specific gravity greater than 0.75, and within four units in the third decimal place for dry gases, or gases having a specific gravity less than 0.75.

2. Where accuracies expressed in the third decimal place are required, the use of a calcium chloride dryer in the air-suction line to the balance is recommended on warm days when the humidity is high.

5. All scale readings shall be made while the operator is in a position directly in front of the apparatus and with the level of the eyes held constant.

E. Calculation of Results

The specific gravity of a gas referred to air as unity may be represented as the ratio of the absolute pressure required for balancing the beam in air to the absolute pressure required for balancing the beam in the gas, expressed as a formula:

$$\text{Sp. Gr.} = \frac{A}{G}$$

where A = the manometer pressure plus (algebraically) the barometric pressure while the beam is balancing in air.

G = the manometer pressure plus (algebraically) the barometric pressure while the beam is balancing in gas.

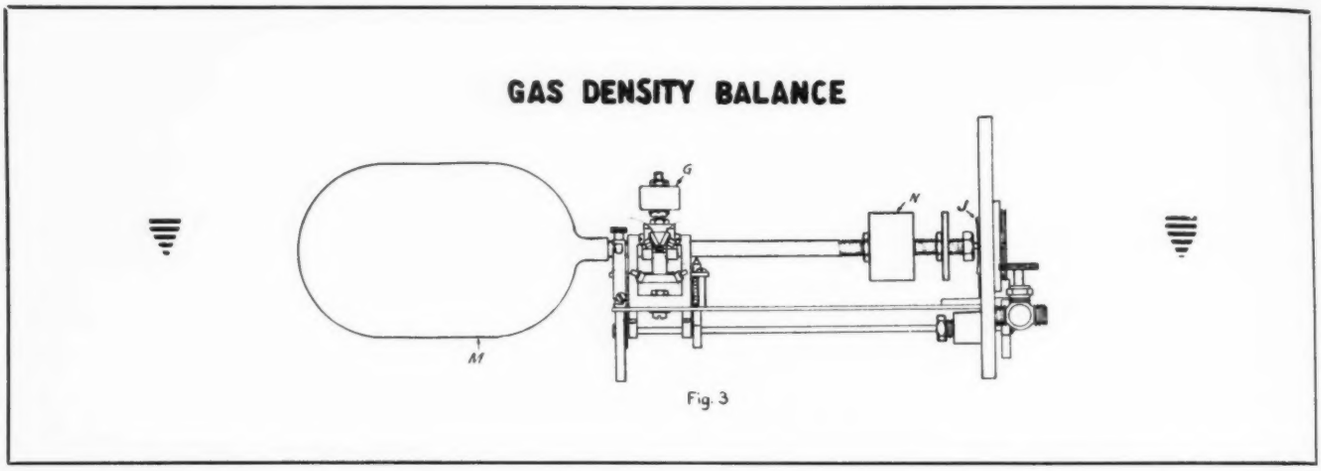

Fig. 3

3. Should any limitation of procedure herein incorporated be impractical or impossible because of any extraordinary conditions encountered, the parties co-operating in a test may agree to modify such limitations.

D. Precautions to Be Taken for the Test

1. The temperature of the balance should be kept constant during the test. Wherever possible, it is recommended the apparatus be shaded from heat or wind or other weather disturbances. Special precautions should be taken to avoid errors resulting from the use of a balance of which the temperature is not in equilibrium with that of the surrounding atmosphere. Reference is made in particular to extreme changes in conditions, such as in removing a balance, shaded in transit, to bright sunlight for the test without allowance for equilibrium temperatures to be reached.

2. Manometers and mercury shall be kept clean so as to permit accurate readings.

3. Condensation in the balance should be avoided. Small drops of liquid on the beam or float will give rise to large errors in the determinations.

4. Serious errors may result from readings taken with the balance beam at rest. This is especially true if there is any degree of friction in the operation of the balance. A travel range of from 6 to 16 divisions on the beam scale shall be maintained at the time readings are made.

The following examples illustrate the calculation of gas specific gravity from assumed test data:

Assumptions of Test Results

First Example	Manometer Pressure mm.	Barometer Reading mm.	Absolute Pressure mm.
Gas No. 1 (G_1)	—91 (vacuum)	736	645
Air No. 1 (A_1)	—1.0	736	735
Second Example			
Gas No. 2 (G_2)	+74	736	810
Air No. 2 (A_2)	—101 (vacuum)	736	635

From the first example, gas sample No. 1 would have a specific gravity determined as follows:

$$\text{Sp. Gr.} = \frac{A_1}{G_1} = \frac{800}{700} = 1.14$$

From the second example, gas sample No. 2 would have a specific gravity determined as follows:

$$\text{Sp. Gr.} = \frac{A_2}{G_2} = \frac{635}{810} = .784$$

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Some Engineering Comments on
Operating Conditions in Zwolle Field

By H. D. EASTON, E. M.

DEVELOPMENT work to date in the Zwolle oil field of Sabine Parish, La., has demonstrated some important factors regarding chalk rock production well known to engineers but rather generally overlooked in wildcat prospecting with the rotary outfit:

1. A pay can be drilled through without giving any showings and with no suggestion that such pay exists.

2. If showings are noted or suspected and a bailing test is made after setting casing, still a pay can be passed up.

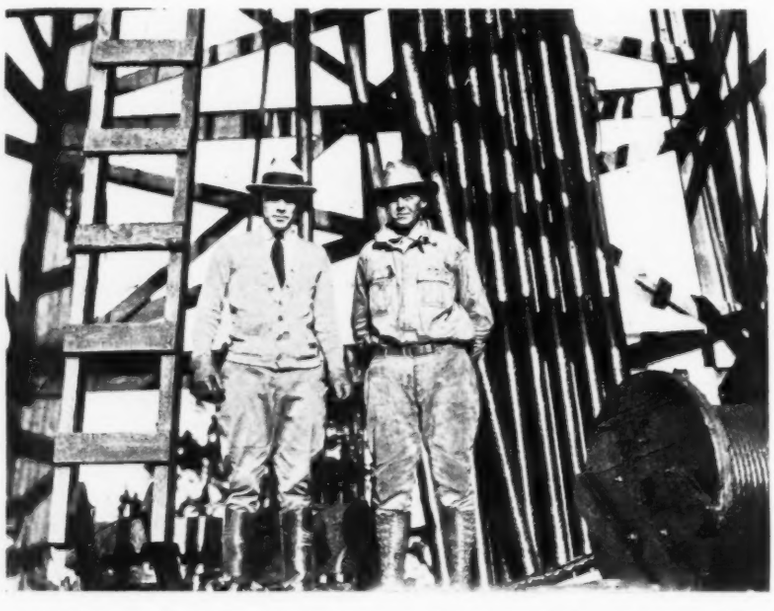
If these statements are true as applied to prospecting the Chalk Rock at Zwolle, they may be equally true in searching for pays in other formations.

These are largely engineering problems which have been worked on and are being worked on with a slow measure of improvement, but additional discussion, with concrete examples, may not come amiss. Before describing the experiences encountered in the Zwolle Chalk Rock prospecting, it should be noted that most of the improvements in coring, testing, etc., have come into use during the past seven years and that we have reached a time when there is a great deal of engineering study being given to all phases of the oil industry, including the work of prospecting. The writer had an article in "Oil Weekly" back in July, 1923, in which some rather interesting examples of common errors were mentioned, and he urged the use of the corebarrel under scientific supervision. Since that time we have come into somewhat more advanced methods of prospecting: we have several types of corebarrels, we have paleontologists studying cores and cuttings, and we have the drillstem sand testers. However, we have fallen short of what constitutes absolute mechanical perfection, and (what is the crux of the whole matter) we have but partially educated the management to the obvious fact that any wildcat drilling that costs from $25,000.00 on up deserves additional expenditures for keeping an engineer on the well—instead of costing something additional; an engineer on the job might, and probably would save several thousands of dollars in most cases.

When one looks at construction jobs of all kinds, in all lands and under all conditions, and instinctively knows there must be an engineer on the job, he feels, instantly, the folly of not having one in charge of prospecting, and it becomes evident that the management of wildcat prospecting holds different views along this line.

It is true that much engineering study and useful ingenuity are being applied to such features as crooked holes and to the general development work of oil fields where there is hurry-up drilling. Herein, we are considering wildcat prospecting and the search for new pools, and this is the work that still lacks engineering supervision.

H. D. Easton



Gene Morehead of the Simms Oil Co. (left), and P. E. Campbell, in charge of drilling for R. L. Gay at Zwolle.

How Zwolle Chalk-Rock-Wells Came In

Before any commercial well was completed at Zwolle, one hole was drilled to 2,628 feet and junked. It found the top of the Chalk Rock at 2,131 feet and was nearly through it when junked. It gave showings of oil, in cores and on the returns, while drilling below 2,580 feet. The derrick was skidded 66 feet and another hole was junked at 1,558 feet, not reaching the Chalk Rock. Another skidover was started and drilled to 4,007 feet where it was junked. This deeper hole had good showings of oil and gas in the Chalk Rock at 2,442 feet. It had much salt water in the Blossom sand below the Chalk Rock and had several large oil shows below the Blossom. It is not intended to discuss the questions of geology, deeper pay zones, etc., but merely to consider the Chalk Rock oil and how the wells acted. This first location, on which two holes went to the bottom of the Chalk Rock, gave information as to the presence of oil near its base.

A new location was then made, handled under the management of R. L. Gay, Trustee, and known as Bowman Hicks Lbr. Co., No. 1. This resulted in the discovery well of the Zwolle structure and came in on Thanksgiving Day, 1928.

This well cored a very small fragment of sand (found in the muck carried in the corebarrel) which contained oil, and it showed considerable gas pressure, just above the Chalk Rock. A drillstem tester managed to allow some gas to enter the drillstem: this gas squirted the fluid out whenever a fourble was broken out. Casing was set (8¼ in. at 2,111 ft.) and the well was flowing into

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tanks on December 1, 1928, at the rate of 50 bbls. per day of 44 gravity oil. It is still flowing and has shown a slow increase until it is making more than 170 bbls. per day.

This is Chalk Rock oil which has migrated into a patch of sand resting directly upon the Chalk although its paleontological reaction shows it to be a remnant of the Nacatoch, there being some forams present to prove this, and it was considered a Nacatoch well until later drilling proved otherwise.

Gay's Bowman Hicks No. 3, the second completion as a commercial well, is a location southwest of the discovery well. After reaching the Chalk Rock it bailed dry in the zone of the discovery well and no sand was found resting on the Chalk Rock. Deeper drilling was resorted to, the next 12 feet being hard Chalk Rock followed by softer and more granular Chalk to a total depth of 2,177 feet with good showings of oil in the returns. It bailed almost bone dry, there being but a few gallons of oil and salt water and a fair showing of gas. Tubing was placed in the well and it averaged but 11.75 bbls. per day for the first 45 days. It is still flowing and has slowly increased until it is producing over 100 bbls. per day with almost no water. It has furnished gas for drilling.

Gay's Bowman Hicks No. 4, the third producer, is a west offset to the discovery well. It showed no signs of oil or gas at the two zones mentioned above, so it was drilled deeper without any bailing test. At a depth of 2,350 feet, which places it near the middle of the Chalk Rock, it had good showings of oil on the returns and bailed in as a pumper. It went on the beam October 6, 1929, pumping 75 bbls. of oil accompanied by 38 bbls. of salt water. It has increased right along and is making more than 260 bbls. of oil and about the same amount, possibly less, of water than it did at the beginning. The oil separates instantly from the water.

Gay's Bowman Hicks No. 5, a south location to the discovery and the fourth well, gave no showings at the depths of the three other producers but it was not bailed at these depths. It was drilled on down to 2,587 feet (nearing the bottom of the Chalk Rock) without the slightest showing—except a white scum on the returns—and bailed dry November 26, 1929. The second day it showed a hatful of oil and water; the fourth day it looked good for a small pumper and standard rig was ordered; the seventh day it was overflowing the 8¼-inch casing and made a big head through the crown-block. It continued to flow by heads at the rate of 50 bbls. per day until it started pumping 150 bbls. on December 15th with every intimation that it will increase as have the others.

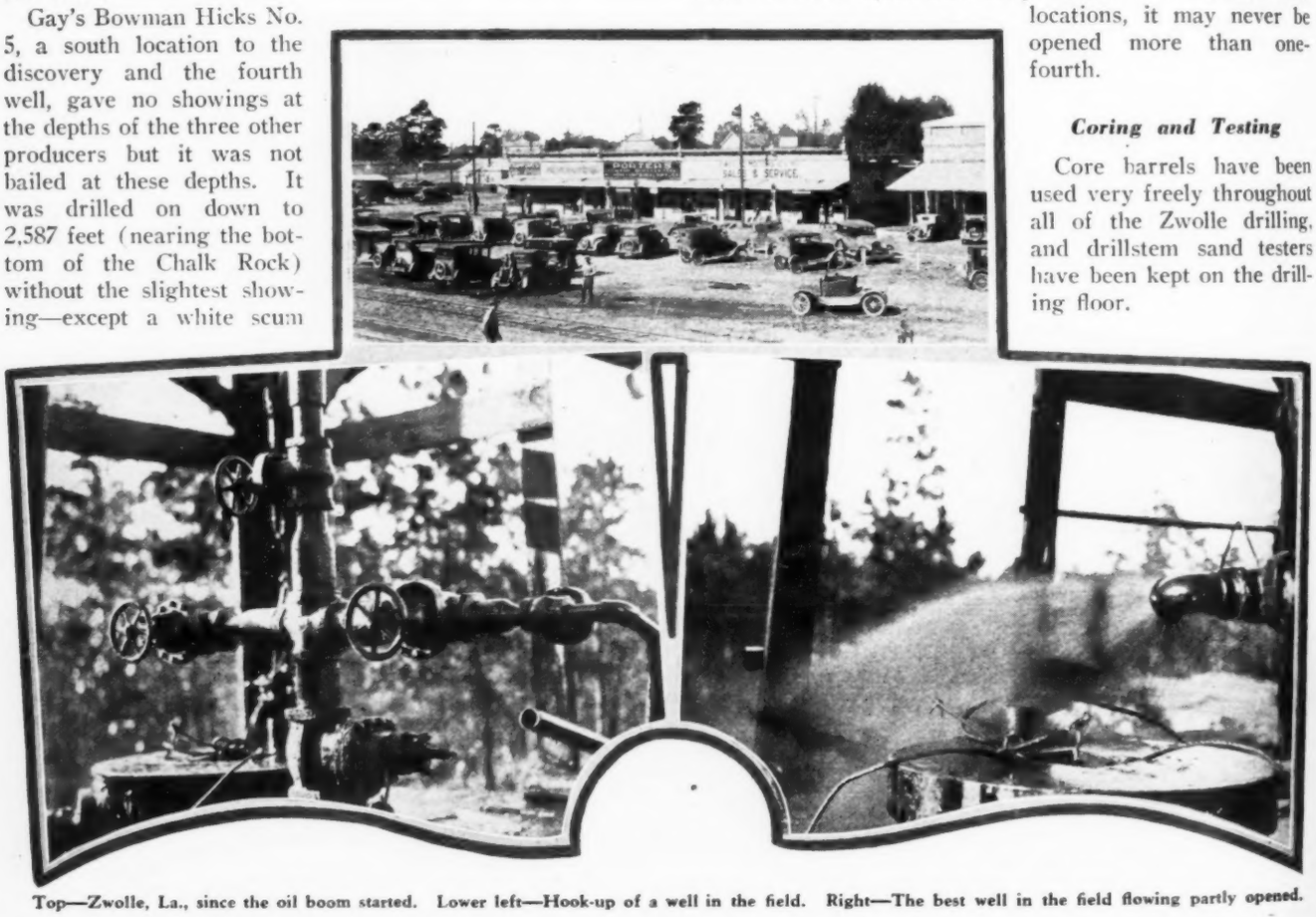
Each of these last three wells has its casing set at 2,090 feet so as to include any Nacatoch that may be present on top of the Chalk Rock, and it is probable that future practice will be to set at this depth before drilling any deeper. The Chalk Rock takes up the drilling fluid rapidly and it seems the best practice to set casing and then drill in with clear water and bail at once.

Gay's Bowman Hicks No. A-1 is located twelve miles east-northeast of these first four wells. It found the top of the Chalk Rock 26 feet shallower in relation to sea level. Its elevation is 334 feet whereas the others are around 160 feet, and its depth to the top of the Chalk Rock is 2,330 feet as compared with 2,130 feet in the others. After coring ahead through the upper portion of the Chalk Rock, it found a showing of oil in granular chalk at 2,405 feet, stopped at 2,413 feet and set 8¼-inch casing at 2,398 feet.

When the plug was drilled on November 26th, the well blew in before the drillstem could be pulled. No liner was used or needed. The drillstem was pulled and an old gate attached while a solid column of oil remained steady near the top of the derrick. With the gate closed as tight as possible, the well continued to make better than 3,000 bbls. daily, the oil being 41.5 gravity and dark green in color. The Standard Pipe Line Company rushed a 4-inch line to quick completion and then followed by a 6-inch line. The well has not been fully opened for a gauge, but it is estimated as above 20,000 bbls. daily. Since there are no offset locations, it may never be opened more than one-fourth.

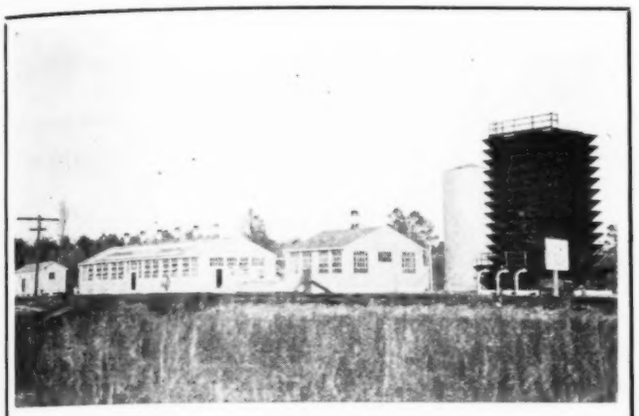
Coring and Testing

Core barrels have been used very freely throughout all of the Zwolle drilling, and drillstem sand testers have been kept on the drilling floor.



Top—Zwolle, La., since the oil boom started. Lower left—Hook-up of a well in the field. Right—The best well in the field flowing partly opened.

Cores have given much information as to age, thickness, composition, etc., of the various formations. Core barrels are considered almost as necessary as the drilling bit itself, yet there are features connected with their use which must be taken into consideration: (a) The greatest amount of information is obtainable only on the drilling floor and at the very time the cores come out of the ground. A careful inspection of the entire content of the core barrel (including muck) may show some evidence of oil or gas, yet such evidence might not be found through a careful inspection in the office. In some cases at Zwolle, the vital part of the formation cored was not recovered: in other cases, evaporation was so rapid that paleontologists could detect no oil although the odor had been very pronounced when the core first came out. (b) If cores are to be sent in to the office, they should include the entire content of the barrel, including muck. If portions of a core show oil or gas at the well, these should be sealed by some such method as plastering them with clay and then wrapping them so the clay will not dry out and crack. I have received cores several days after taken and found them to carry gas; because of this treatment the gas was retained. (c) One should expect the driller to find the pays and should make every effort to encourage a feeling that everything done in taking cores, making drillstem tests, etc., are matters helpful to his success. Too often it happens that a driller is wholly neglected and he is thus led to feel that nothing is wanted of him except hole; on the other hand, it may happen that cores are grabbed away from him hurriedly and he is made to feel that his opinion is not worth considering. A good driller is an intelligent man who should be fully backed in his search for oil. In wildcat drilling the sand tester should be kept on the derrick floor. Its most satisfactory use depends upon its going into the hole as soon as possible after drilling indicates the desirability of a test. There should be no time allowed for mud to work back into the zone which is to be tested.



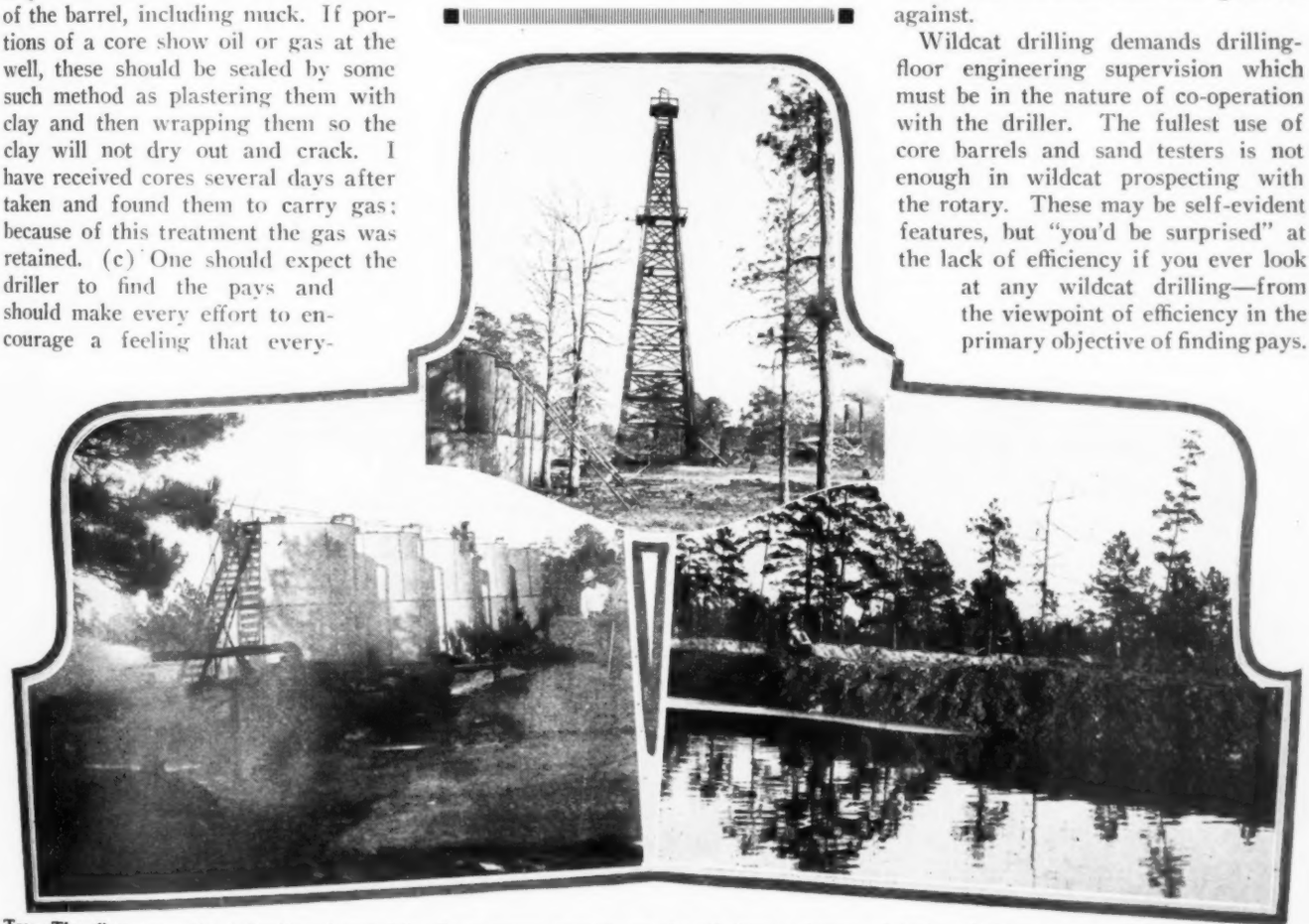
Reserve Natural Gas Corp.'s compressor station at Springhill, La.

A swamp part of the Smackover, Ark., country on a nice day.

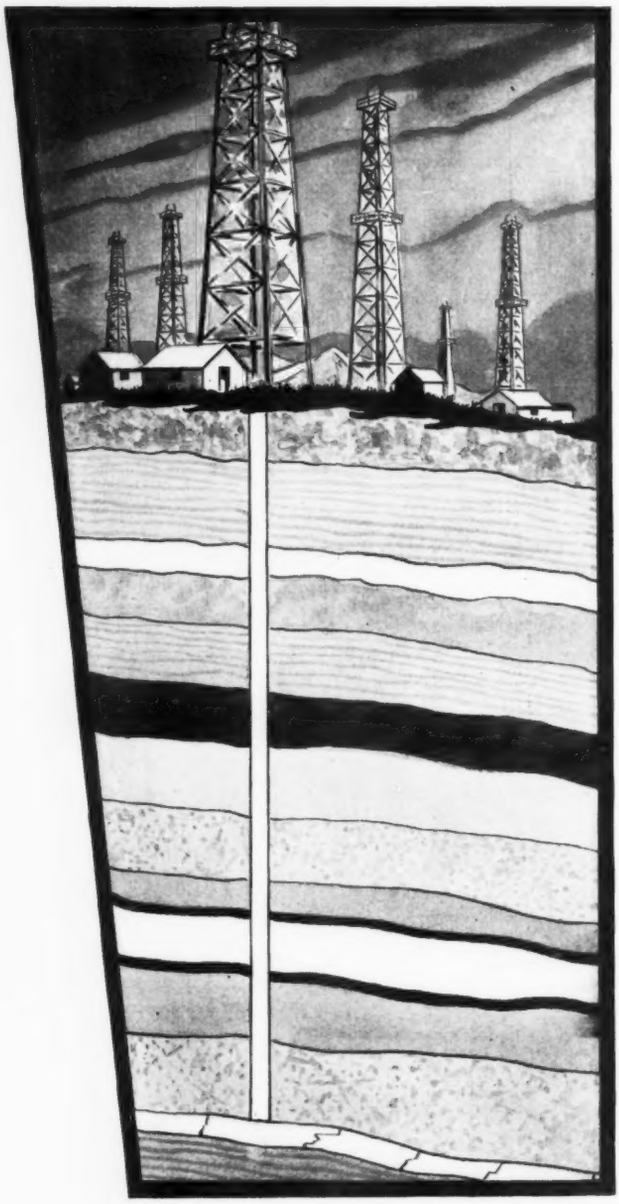
Conclusion

The limitations of all apparatus and machinery should be taken into consideration and guarded against.

Wildcat drilling demands drilling-floor engineering supervision which must be in the nature of co-operation with the driller. The fullest use of core barrels and sand testers is not enough in wildcat prospecting with the rotary. These may be self-evident features, but "you'd be surprised" at the lack of efficiency if you ever look at any wildcat drilling—from the viewpoint of efficiency in the primary objective of finding pays.



Top—The discovery well at Zwolle. Lower left—Steam pump running out the oil from a battery of tanks. Right—An earthen pond used for temporary oil storage.



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Reclaiming Waste Sulphides to Lead Oxide

By D. F. GERSTENBERGER [1]

METHODS and costs of chemical treatment are of prime interest to every refiner. The requirements of the trade in most districts call for gasolines which are doctor sweet, pass the corrosion test, and have a good odor and color. The necessary treatment of gasolines to make them comply with these requirements, is not productive of profit but is actually a necessary evil which increases the manufacturing costs of the finished product.

One of the most satisfactory and commonly used methods of treating gasoline is the sweetening process which consists of contacting the product, either by circulation or by air agitation, with what is known as a doctor solution. Such solution is made up by saturating an aqueous solution of caustic soda with lead oxide, more commonly called litharge. A concentrated doctor solution contains approximately .564 pounds of caustic and .160 pounds of litharge per gallon.

The most expensive component of the solution is the litharge, and in view of its attraction for certain sulphur compounds in the gasoline, it is used up more quickly than the caustic. The result of the reaction between the sulphur compounds in the oil and the lead oxide in the doctor solution is the formation of what is commonly called blackstrap, or lead sulphide. This is a black looking substance, sometimes flocculent, and sometimes granular, but which in every case will eventually settle to a heavy mass of solids.

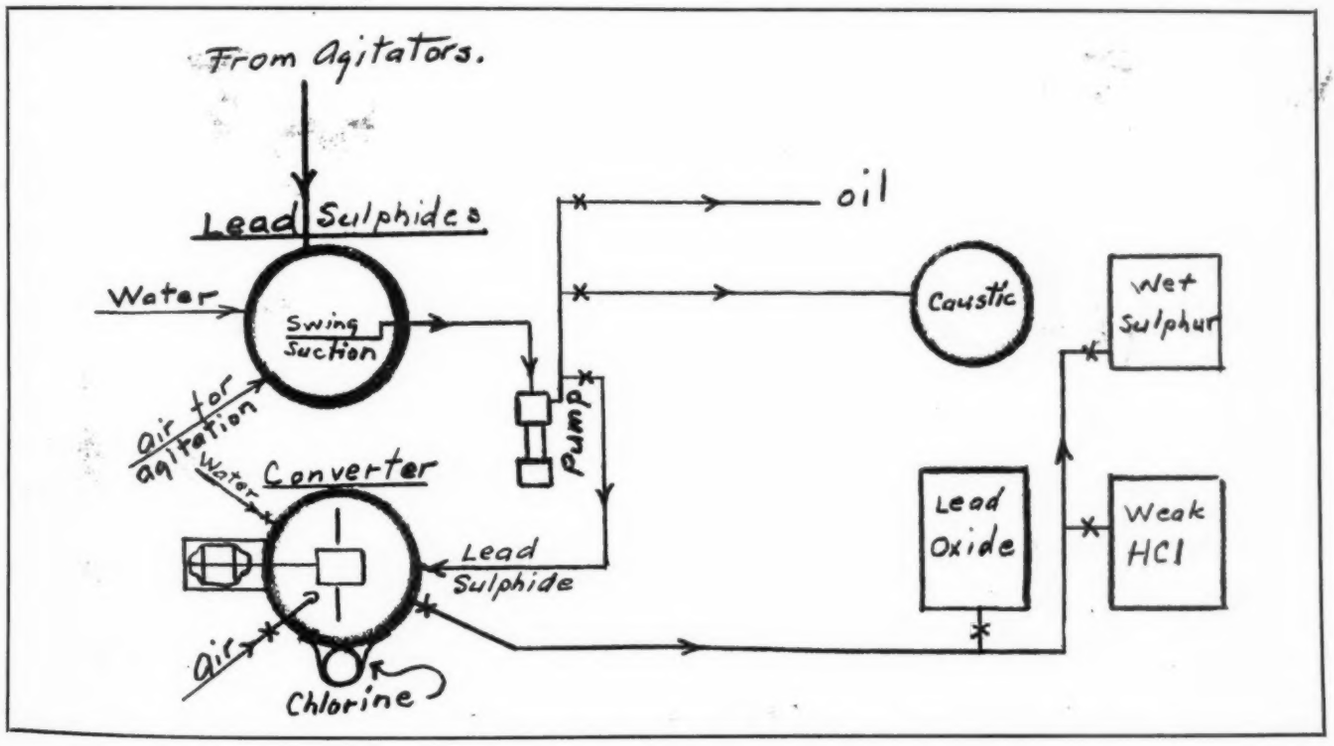
This material is usually a waste in most refineries, or at best it is segregated, dried and sold to the chemical trade at a nominal price, which doesn't much more than cover the cost of handling.

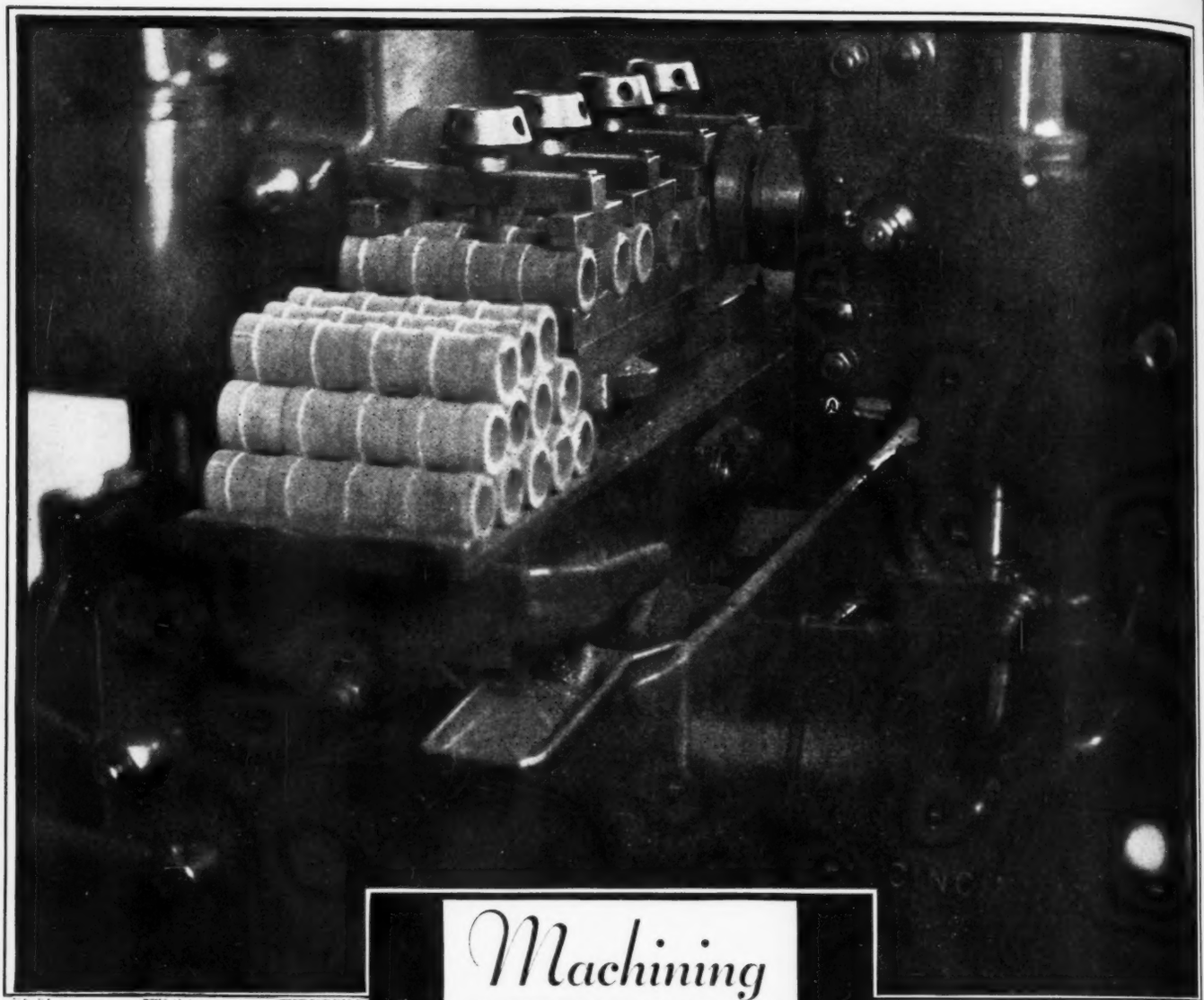
Recent developments have shown these sulphides to be of extreme value to the refiner in that it is possible to convert them back into their original components of lead oxide, and sulphur, which can again be used in the treatment of gasolines and kerosenes at a surprisingly low cost, with as good a treating effect as fresh chemicals, and sometimes on certain products, with better results.

Such a process is owned and patented by the Plumbite Recovery Company and is known as the F-C Plumbite Recovery Process. The first commercial plant was installed at the refinery of the American Refining Properties at Wichita Falls, Texas, and was worked out to a simple and efficient operation in large scale by the combined efforts of the licensor and the refinery chemist and management.

The method of recovery is simple. It consists first of settling the lead sulphides out of the spent doctor solution. All caustic solution is then withdrawn, and by agitating the settled sulphides with water, any small additional amount of caustic remaining in saturation in the sulphides is removed. A small amount of weak acid or acid water can also be used to insure the entire removal of all traces of caustic. The sulphides are then agitated with water and transferred into the convertor. Here they are contacted by mechanical means with chlorine and oxidation takes place oxidizing the sulphides back into lead oxide and freeing the sulphur. When the reaction is complete there are three distinct layers namely, wet sulphur, weak hydrochloric acid, and lead oxide. The convertor is so designed that the sulphur and weak acid can be withdrawn leaving the litharge, which is in turn given several water washes until all acidity is removed. It is then transferred in the wet state into a separate tank where it is available for re-use. The sulphur is also washed of any acid and can also be re-used where required in treating. The accompanying sketch shows the equipment used, and the flow of the plumbite through the process.

[1] Manager, American Refining Properties, Wichita Falls, Texas.





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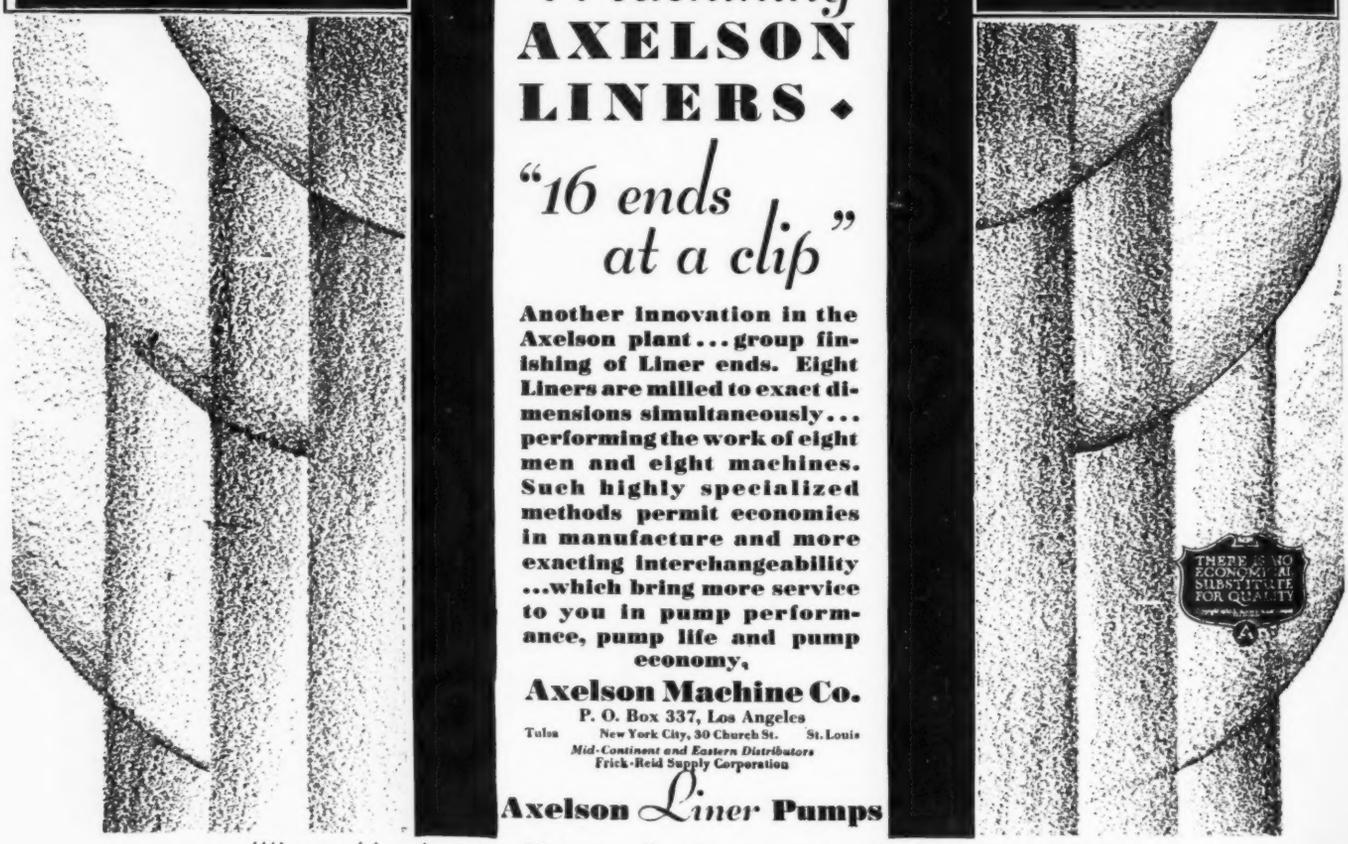


When writing AXELSON MACHINE CO. *please mention The Petroleum Engineer*

The type of equipment required is not expensive, in the case of this first installation, with the exception of pipe and fittings, being furnished mostly from material on the ground.

The operation is so simple that it does not require the employment of skilled or technical labor. In fact in most refineries it could be operated by the regular treaters at no additional labor cost. The value of the reclaimed lead oxide as a treating agent is quite interesting. It is a well-known fact that cracked gasoline is harder to treat, usually, than straight run gasoline. Also in some instances there is a tendency to a slight loss in color in sweetening cracked gasoline. It was found here that the reclaimed lead oxide in the doctor solution was just as good a treating agent for the straight run gasoline as the new commercial litharge, but in the case of cracked gasoline it was a superior agent. The oil broke more quickly and settled out more rapidly and the color was actually improved by this treatment. This is probably explained by the fact that the recovered litharge is much more finely divided than new lead and it probably contains a small amount of elemental sulphur which is quite active in bringing about a break. The finished product from this treatment is excellent in every respect.

The actual value of this process to the refinery for the recovery of every 1,000 pounds of lead oxide are as follows, assuming a black-strap containing 85% lead sulphide and 15% sulphur, in the usual caustic solution.

RECOVERY.

1,000 lbs. litharge @ 9.75c per lb.	$97.50
140 lbs. sulphur @ 2.75c per lb. (chem. comb.)	3.85
150 lbs. sulphur @ 2.75c per lb. (free)	4.13
Total	$105.48

COST OF RECOVERY.

320 lbs. of chlorine @ 3c per lb.	$ 9.60
Steam, labor, power	5.00
Total	$14.60
Return for 1,000 lbs.	$ 90.88

In addition to the above is the fact that every time a batch of doctor solution is discarded, the caustic soda is discarded with it. The quantity in a batch of doctor containing 1,000 lbs. of lead is approximately 2,000 lbs. which at the price of 2.90c per lb. is worth $58.00 making the actual net value of reclaimed products $148.88.

The chemistry of the reclaiming is as follows:

$H_2+2Cl=HOCL+HCl$

$HOCl+PbS=Pbo+S+HCl$

E. G. Goddard Passes On

E. G. Goddard, southwestern general manager of the Goulds Pumps, Inc., of Seneca Falls, N. Y., and with his own headquarters at Houston, Texas, died Saturday, January 4, a wire received by Edw. Soph, manufacturers agent, said. Mr. Goddard had been serving the oil companies with pumps for more than 25 years and had an intimate acquaintanceship with many of the leading producers and pipeline men of the Mid-Continent field. His body will lie in state Sunday at Houston and be taken to San Antonio for cremation Monday. He is survived by his widow.

Give Your Wells Complete

TUBING PROTECTION

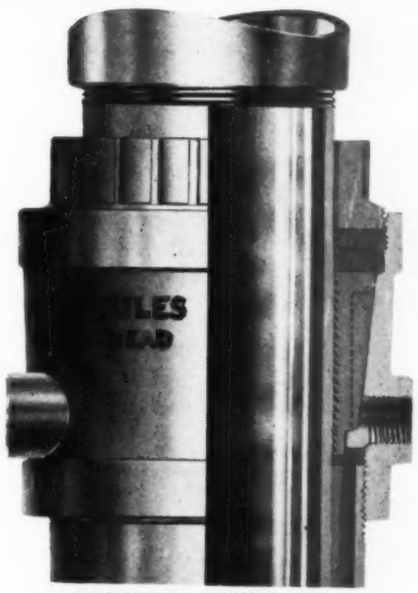
—with the—

Hercules Tubing Hanger

HERCULES TUBING HANGER
Cross Section View
(Patent Pending)

Adopted as standard equipment on hundreds of wells, these two Hercules Tools protect your tubing and casing against dropping while suspended in the well. A few dollars spent now for protection may save hundreds spent later as cause of some accident that the Hercules Tubing Hanger and Casing Head will prevent.

HERCULES CASING HEAD



HERCULES CASING HEAD
Cross Section View
(Patent Pending)

These tools are especially adaptable to high-pressure wells. *For sale at leading supply houses. Write for descriptive folders and prices.*

Hercules Tool Company

Tulsa, Okla.

Phone 3-2358 P. O. Box 286 Palace Bldg.
Cable Address: "Contico" St. Louis and New York, All Standard Codes.

Continental Well Has

Natural Gas 136 Degrees Below Zero*

By H. B. SIMCOX[1]

THE North Park country near Walden, Colo., has a great deal of weather and three-fourths of it is generally cold enough to suit an Eskimo's fancy. When the Continental Oil Company began drilling on the North McCallum structure in the Walden region, it was understood that the 8,200-foot-above sea-level mountain climate might offer numerous obstacles; but there was no premonition that the oil they discovered would be even colder than the most frigid weather and bear a striking resemblance to lemon sherbet. But from the beginning, the drilling of the cold well is a narrative of surprises.

The drill reached its goal and brought to the surface a gas flow averaging between eight and ten million cubic feet a day. The well gradually drilled itself in, and the next day it was making around 35 million cubic feet of gas and spraying the sky with a cloud of what appeared to be steam and soft, flaky snow. This "snow" would pile up on the derrick floor in yellow, slushy mounds from six inches to a foot deep. It even dripped off of the belt house and derrick roof.

An examination of the "slush" revealed that it was nothing more than frozen crude oil. This was something new in petroleum history. Who ever heard of oil getting cold enough to freeze, and why should it be anything but warm down there more than a mile below the surface?

H. B. Simcox

A short time after the well had been capped and the separator, tanks and other equipment aids to production ordered, a chemist fought his way through the snowdrifts to inspect the freak well. After he had worked with his instruments for a while, he declared that the gas was approximately 90 per cent carbon dioxide and would not burn. But the biggest surprise came when he mentioned that the temperature was 136 degrees *below zero.*

Engineers say that enough carbon dioxide flows from the well to make possible the manufacture of six times the present output of "dry ice" in the United States. Dry ice is nothing more than solidified carbon dioxide which is being used as a refrigerant. It is extremely cold and absolutely dry. It would be possible to manufacture 1,500 tons of dry ice a day from the Walden gas flow.

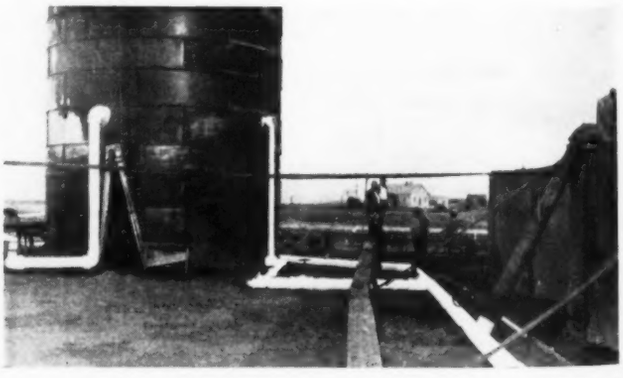
Melting the oil was a problem which caused considerable grief. It would not flow through a pipe due to the fact that the gas expansion in such a constricted area made the oil still colder and caused it to freeze solid and block the line.

Finally the representative of a certain tank company suggested that an extra large flow tank be used. This would give the gas more room in which to expand. He also suggested that approximately five feet of hot water in the bottom of the tank would hasten melting. This plan proved to be a suitable one, and by placing extra gas vents on the top of the tank the entire flow of the well could be taken care of immediately. It taxed the capacity of two 45-horsepower boilers to keep the water in the bottom of the tank hot enough to melt the slush oil.

When the oil had passed into the storage tanks the gauge showed about 300 barrels of oil and not a drop of water. The oil was a straw color and so clear in a low 500-barrel tank that one could see the rivets on the bottom.

After the well had flowed for a year with only 40 pounds of back pressure, it was making the same volume of gas, 34 million cubic feet, with the rock pressure standing at 800 pounds. This is an unusual record.

* Printed through courtesy Conoco Magazine.
[1] Assistant Manager of Production, Continental Oil Company.



The lead lines from the "Lemon Ice" well and the risers and lines connecting to the tanks are covered with frost, as shown above, even in summertime.

Unitization Plan Adopted in Newly Discovered Pool

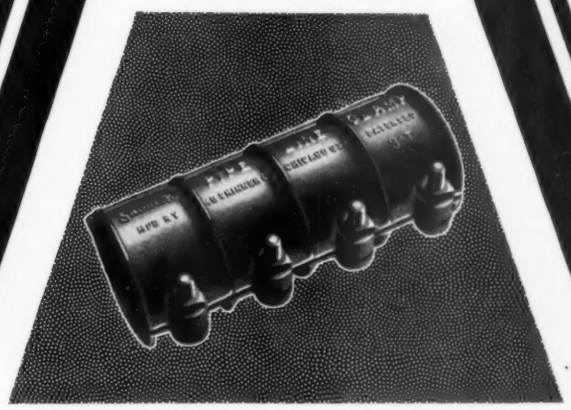
TAKING on added significance at a time when oil production is under proration in all districts and efforts are being made to increase operating efficiency and reduce production costs is the recent announcement of the adoption of the unit plan of operation in a recently discovered field in Texas. Although only a few wells have been drilled in the Van field, Van Zandt County, Texas, 5800 acres have been consolidated for unit operation. Of this acreage 82 per cent is held by the Pure Oil Company and the remaining 18 per cent by the Humble Oil and Refining Company, Sun Oil Company, Texas Company and the Shell Petroleum Corporation. An operating agreement has been reached whereby the Pure Oil Company will develop and operate the pool as a unit. An operating committee composed of a representative from each company will act as a board of executive management and decide questions regarding the general plan of development and operation.

Under the general terms of the agreement, which runs for two and a half years and is tentative in character, each company will contribute to the expense of development and operation in proportion to the acreage it holds. On the same basis the revenue derived from production will be disbursed. At the expiration of the agreement, however, an adjustment of acreage values, based on a field appraisal, will be made and an equitable settlement made. A new operating agreement will then be drawn up to extend over another two and a half years, at the termination of which in turn a revaluation will be made of the field and an adjustment and settlement made accordingly. The adjustment of values will be based on valuations made by three engineers of recognized ability, one each chosen by the president of the American Institute of Mining and Metallurgical Engineers, the president of the American Petroleum Institute and the director of the U. S. Bureau of Mines.

An interesting and encouraging feature of the plan is the fact that the companies were able to agree on the acreage that should be included in the pool. To the acceptance of this acreage by the companies concerned, much was probably attributed to the thorough nature of the exploratory work that had been done. The first exploratory survey was made by a seismograph party in the employ of the Pure Oil Company. It indicated a large anticline, suggesting a deeply buried dome. Then followed a detailed survey of the areal and structural geology of the region. Between January and July, 1929, the area was thoroughly tested with the core drill. Showings of oil and gas confirmed the work of the geophysical and geological surveys. On October 13, 1929, the Pure Oil Company completed the first well, its Jarman No. 1, at 2710 feet, in the Woodbine formation, for an initial production of 147 barrels an hour. Within less than two months of the completion of the first well and when only a few wells had been brought in, companies holding acreage in the field pooled their holdings, based on the limits of the pool outlined by exploratory work, got together and agreed on the unit plan of development and operation.

Of far-reaching importance in the history of the oil industry in furthering more orderly field development, more efficient production methods and better oil recovery, this field bears watching. For the next few years, at least until the expiration of the first operating agreement, when the results of unit operation can be appraised, the Van field will probably be the cynosure of the eyes of the oil industry.

SKINNER



Pipe Line Clamp

***for* repairing long splits in pipe**

This strong, simple Clamp is designed particularly for repairing long splits and lines that are corroded for six or eight inches. Absolutely permanent.

Made with the Skinner principle of bolts on one side only—a hinge on the other. The nuts are always on top. Made in all standard pipe sizes, from one inch to six inch, inclusive.

The Skinner Pipe Line Clamp is particularly valuable during the freeze-ups of the "Norther" season.

M. B. SKINNER COMPANY

Sample Street at Falcon St., South Bend, Ind.

When writing M. B. Skinner Co. *please mention The Petroleum Engineer*

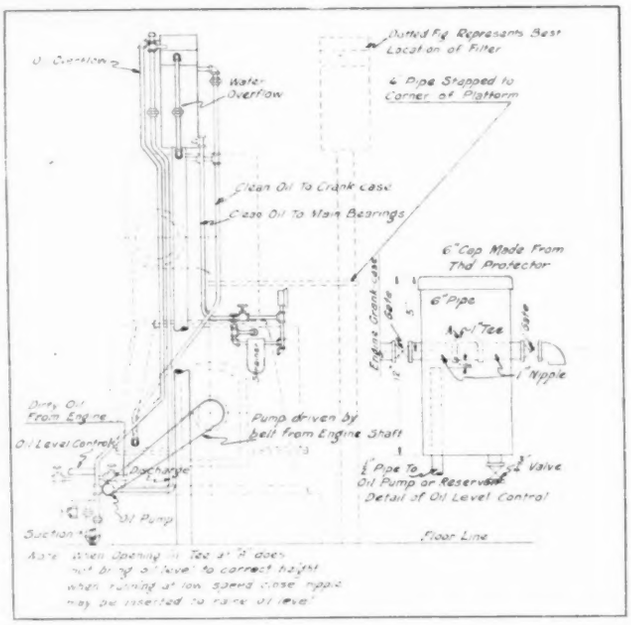
Device Sets Oil Level *for* Gas Engines

TO insure proper lubrication on a group of gas engines driving pumps on an oil line, A. L. Bradford, Superintendent of power for the Magnolia Gas Company, devised a simple shop made oil level that keeps the proper amount of oil in the crank case at all engine speeds. The result of the inexpensive device has eliminated most of the troubles which were caused by too much or too little oil.

The Magnolia company has an oil line running from South Arkansas to Beaumont, Texas, which parallels a gas line most of the route. Therefore, gas engines are used where possible, to drive the pumps.

At the time the level control was tried out, trouble was experienced by too much oil being put in the crank case. This caused carbon troubles resulting in the engines running too hot, and some of the carbon fell off and clogged the oil ways which served the main bearings. From this extreme the trouble went to the other of not enough oil; therefore, the necessity for a controlling device.

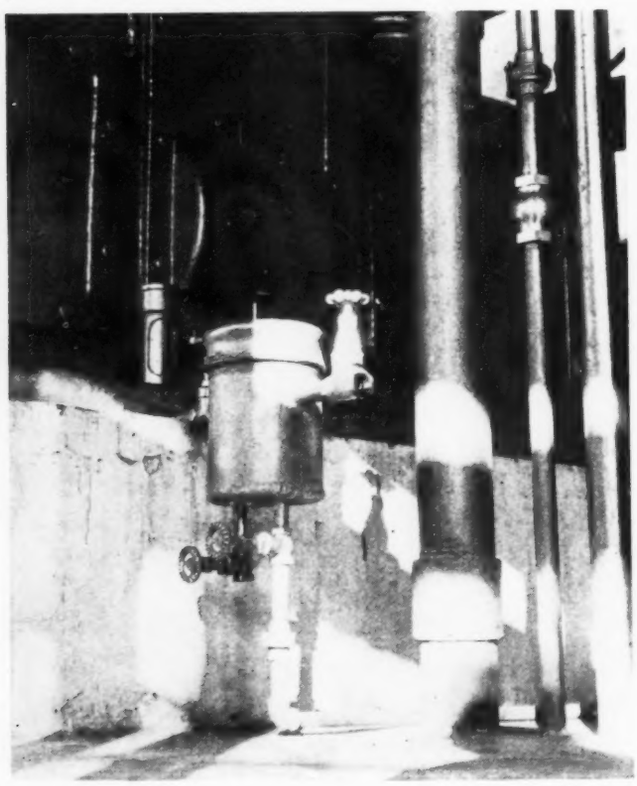
The level control is made with a piece of 6-inch pipe with a half inch pipe inserted horizontally about the center, and with an upright Tee connection in the center of the half inch pipe. The half inch pipe connects to the crank case drain on the engine. Any desired level of oil can be kept in the crank case by screwing a nipple of the proper length into the Tee. A cap for the level is made with a thread protector, by welding a disc in the top and welding a handle to it.

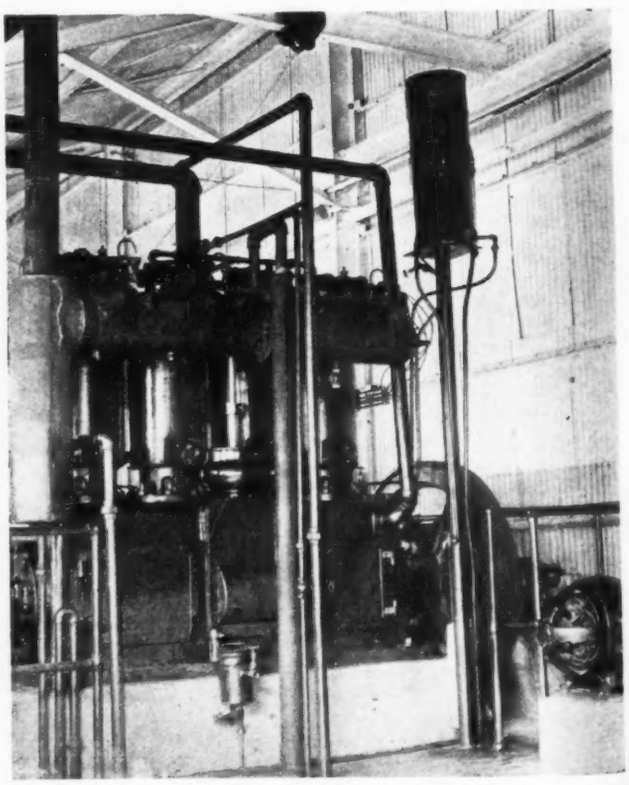


When the device was first installed it was desired to have the cups make a scant eighth of an inch dip, at high speed.

To obtain the proper quantity of oil, what was believed to be the correct amount was put in the crank case. The engine was started and run at the desired speed. All of the nuts on the crank case plate were removed except two. When the engine was stopped these were taken off and one of the cups moved to bottom center. The depth of dip of the cup was taken before all of the oil dripped back into the crank case, and these measurements were used to regulate the oil level. The proper level is maintained by the insertion of close nipples in the oil level control.

When these were installed filters were made at the same time and placed over the engine in order that they could get the advantage of more heat for filtering. The entire layout was made at a nominal cost.





Settled Production Is "Bread and Butter"

PARTS of a letter from E. J. Nicklos, vice-president and manager of production for the Continental Oil Co. is printed herewith through courtesy of Conoco Magazine.

"The petroleum business has undergone great changes in the last few years, which is particularly true in the drilling and producing of oil. Wells are drilled to greater depths and, consequently, lifting the oil to the surface presents a more difficult and expensive problem. We are producing oil from a depth of 8,523 feet in Reagan County, Texas, which at this time is the deepest producing well in the world.

E. J. Nicklos

The cost of producing oil, in view of the above, and getting into our tanks has materially increased. In order to make every operation a profitable one, lifting costs must be held at a minimum. Constant, personal supervision will go far toward accomplishing this result. Production is usually classified as flush, semi-flush and settled. The settled production is our 'bread and butter' and it must be most carefully watched so that the maximum amount of oil can be produced at the lowest possible cost.

"The task of securing the maximum amount of production from each well on every lease is in the direct responsibility of our Foremen and Pumpers. These men are the custodians of a very large investment and must recognize their duty as well as their responsibility.

Certain codes and rules have been set up by the management of this department, and all those in a supervisory capacity are charged with the responsibility of enforcing them in all of our operations.

"Many items affect our lifting costs, such as wages, fuel, taxes, teaming and trucking, supplies, depletion and depreciation.

"The pumper who maintains his powers, engines, buildings, rod lines and jacks, in first class condition; who watches his small tools, supplies and lubricants, and many other items; who has gas tight tanks with hatches closed; stuffing boxes without leaks; who removes all fire hazards and conditions which may cause personal injuries, will always be able to show the greatest efficiency and lowest lifting cost, and, it follows, more uniform production.

"Every well is an individual problem which must be studied as to its action and pumping equipment to the end that the maximum amount of oil is produced with the least trouble and expense.

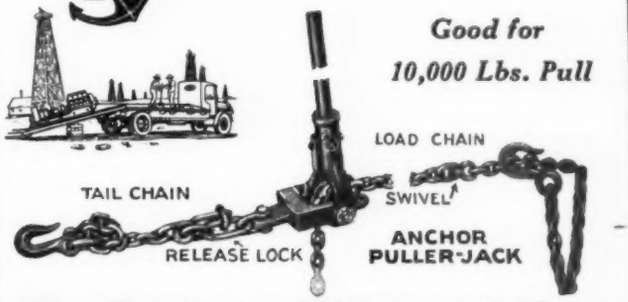
"Pollution of properties is an evil which must be constantly watched and avoided. One lawsuit from this cause can wipe out the profits from several months' production, and, consequently, affect our lifting costs, not only on some particular lease, but for this department as a whole.

"This department has resolved to keep operating expenses as low as possible to assure the maximum profit from every operation, to build up a loyal and efficient organization, and to give the fullest co-operation to every department. This can be done and must be done."

"Anchor" Puller-Jack — A One-Man Gang

Trade Mark

Good for 10,000 Lbs. Pull



The Tool of a Thousand Uses

A new, a quicker, cheaper way to handle the jobs of pulling, moving, lifting heavy loads. Pulls the length of the load chain at one hold. Easily released.

A Few Uses

Handles heavy machinery and boilers.
Yanks out mired trucks.
Tightens guy lines and pull rods.
Pulls boiler tubes.
Spots railroad cars.
Pulls belts and chains for splicing.
For construction and erection work.
Or what have you?
Complete outfit $36.00, f. o. b. works, Reynoldsville, Pa. Get it from your supply jobber or order direct. Send for bulletin P.

Sheave block included.

T. H. EDELBLUTE COMPANY
Oliver Building,
Pittsburgh, Pa.

A one-man outfit.

Skinner's Cord Belts

are built on a basically new principle. Will hug the pulley tightly and deliver more power.

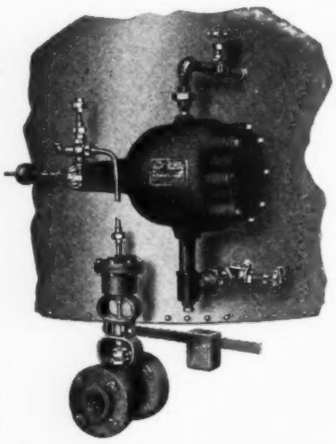
Start using it today

Skinner Bros. Belting Co.

TULSA, OKLAHOMA

VIGILANT
LIQUID LEVEL REGULATORS

A New Type
REGULATOR
For Maintaining Liquid Levels in Refining



MAINTAINS constant level under all conditions of temperature and pressure. May be used to control the outlet or inlet flow.

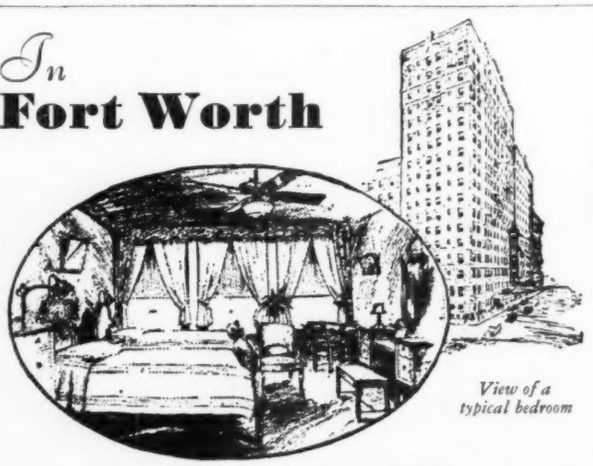
Especially designed for towers employing 600 to 800°F.

Get the latest information about this regulator.

CF

The Chaplin-Fulton Mfg. Co.
28-40 PENN AVE. PITTSBURGH, PA.

In
Fort Worth



View of a typical bedroom

...it's the **Worth Hotel**

. . . Which best typifies to the traveler the modernity and courtesy of the West. Experienced travelers make this their headquarters in Fort Worth. Among the newest of Southern hotels, its modernity is enhanced by considerate appreciation of travelers' needs. To the initiate, it is a welcome respite from ordinary hotels.

WORTH HOTEL
300 Superior Rooms with Bath ~ at $2.00 up
FT. WORTH, TEXAS

California to Hold Interesting Show

The Oil Equipment and Engineering Exposition, which will be held at Shrine Civic Auditorium, Los Angeles, at Thirty-second street and Jefferson, March 16 to 23, will have over a hundred thousand square feet floor space inside, also several large rooms for conventions and two rooms for moving pictures. There will also be outdoor space adjoining building for derricks and large equipment. The total number of exhibitors to date is said to be one hundred thirty-eight of which fifty-four are from outside California. Twenty-six contracts are awaited. Some of the manufacturers who will exhibit are: Air Reduction Sales Co., Axelson Machine Co., Baash Ross Tool Co., Baker Oil Tools, Inc., Bethlehem Steel Corp., Byron Jackson Co., Cameron Iron Works, Inc., Chapman Valve Co., Chicago Pneumatic Tool Co., Crane Company, Darling Valve Co., The Foxboro Co., Inc., General Electric Co., Haynes Stellite Co., Hughes Tool Co., Kerotest Mfg. Co., Lincoln Electric Co., Linde Air Products Co., Linkbelt Co., Lufkin Foundry & Machine Co., McCord Radiator & Mfg. Co., Martin Loomis Corp., Naylor Pipe Co., Powell Valve Co., Reed Roller Bit Co., Southwestern Engineering Co., Stockham Pipe & Fittings Co., Thrift Corporation, Titusville Iron Works, Trimont Manufacturing Co., Walworth Co., Waukesha Motors Co. Officials of the show include C. M. Fuller, president of Richfield Oil Company; Ward Blodgett of C. C. M. O. Co., William C. McDuffie of Pacific Western Oil Company, Neil Norris of George W. Getty, Inc., G. W. Walker of the Texas Company, A. H. Bell of Marland Oil Company, Frank Hill of Union Oil Company, L. E. Lockhart of Rio Grande Oil Company, William Reinhardt of the Shell Pet. Corp. as directors and E. G. Lenzner is managing director. Leading engineering societies are said to be co-operating to fullest extent in holding meetings in auditorium during exposition and oil companies' engineering departments will have exhibits of technical experiments.

Unique Series of Advertisements

In this issue of The Petroleum Engineer appears the first of a series of advertisements by The Republic Rubber Company, Youngstown, Ohio, which is decidedly new from a manufacturer's viewpoint.

In each advertisement in the series a photograph of one of the various Republic Rubber Company distributors will be used and the distributor quoted so that, in reality, he is advertising his own business. The copy is institutional for the distributor and applies to any department of his business.

The Petroleum Engineer will be used to present the campaign to the oil industry and ten additional magazines in other industries will carry the series. The combined circulations of the eleven publications is 160,000.

Approximately forty distributors will benefit by the campaign and from three to four advertisements for each will appear in publications in their respective fields. The various distributors will be furnished with reprints of advertisements pertaining to their company for distribution on their own mailing list.

Natural Gas Leads Fuel Field

NATURAL gas led the fued field in 1928 in the percentage increase over the 1927 record, according to a report just published by the Trade and Securities service of the Standard Statistics Company of New York, received by the Oklahoma Utilities Association. The estimated value of this fuel consumed in 1928 was about 14 per cent greater than in 1927.

"Anchor" Puller-Jack

REALIZING the need for a powerful pulling device that could be easily carried, handled and operated by one man, the T. H. Edelblute Company, Oliver Bldg., Pittsburgh, Pa., developed the "Anchor" Puller-Jack.

The machine itself consists of an arrangement of sprocket wheels, ratchets and pawls, operated by a three-foot handle. The tail chain is fastened to the anchorage and attaches to the machine by a simple release lock which can be easily loosened to release the load under full strain if desired. The load chain is hooked to the load and the loose end of the chain passes through the sprocket of the jack. By a ratcheting movement of the handle the operator pulls on the load and the chain passes around the sprocket, falling loosely below. The standard load chain is fifteen feet long and has a swivel in it. The appliance will pull continuously for the entire length of the chain in one movement.

Longer length load chains can be furnished, if desired, for special purposes. A sheave block is included as standard equipment. When this is attached to the load, it

doubles the pulling power of the jack. This sheave block is also used for making vertical lifts and pulling around corners. The outfit can be used upside down, sideways or in any position.

Certified tests made by the Pittsburgh Testing Laboratory showed the following results within the safety limits of the entire outfit:

Straight Line Pull

One man pulled 4800 lbs. (drawbar pull).
Two men pulled 6500 lbs. (drawbar pull).

With the Sheave Block

One man pulled 6700 lbs. (drawbar pull).
Two men pulled 9800 lbs. (drawbar pull).

The appliance can be used on any pulling job, such as moving railroad cars, pulling out mired trucks, tightening cables and wires, loading and unloading heavy machinery, pulling belts and chains together for splicing, lifting machinery, derrick erection, etc. There are many other uses for it in oil industry operations.

Beecher Represents Institute in Investigation of Explosion

APPOINTMENT of C. E. Beecher, of the Empire Companies, Bartlesville, Okla., to represent the American Petroleum Institute on a committee of engineers which will investigate circumstances attending an explosion December 13 in the Bartlesville petroleum experiment station of the U. S. Bureau of Mines, was announced recently. The American Institute of Mining and Metallurgical Engineers, American Gas Association, the Bureau of Mines and the State of Oklahoma also will be represented on the committee.

"JANUS"

JANUS, old Roman god of doors (gave us a good name for the current month), had two heads; could see fore and aft at the same time, peer into the future and scan the past, without wiggling a muscle.

We ordinary mortals can look just one way at a time. Looking back at 1929, most of us can congratulate ourselves; the year's voyage was a success. True, in October we had a brush with a submerged rock. But . . .

Both the Federal Government and private industry rushed to the rescue. Plans were laid for turning loose billions of dollars to stabilize business.

Looking forward, we feel assured that 1930 will be a banner year for oil and gas.

Now that the Captains of Industry have swung into line, keeping step to Uncle Sam's HEP . . . HEP . . . HEP, it won't be long until the ranks are all filled and General Prosperity takes command.

J. A. Campbell Co.
Natural Gas Engineers

Consulting
Designing
Constructing

Phone 416-93
P. O. Drawer 669
Long Beach, Cal.

Stearns-Roger Mfg. Co., Denver, Mid-Continent Agency

Gott
Water Cans & Coolers
Built to last... you will always be assured of a fresh supply of pure water, when you have a GOTT Water Cooler. Order one now from your supply store.
GOTT Water Cans 1½ gal; 3 gal; 5 gal; and 10 gal.
GOTT Water Coolers 3 gal; 5 gal; 8 gal; 10 gal; and 20 gal.
Gotkool

Keep Pure Water Always Handy

H. P. Gott Mfg. Company
WINFIELD, KANSAS

By Use of Welding

Shop-Made Pipe Line Station

Is Constructed by Sinclair

OLD pipe that is frequently junk material, finds another use in helping to trim the cost of field stations for the Sinclair Pipe Line Co., and at the same time contribute largely in the construction of a neat building. The cost of the building for such a station was reduced appreciably and the construction department gained the advantage of having all of the material used at an adjacent warehouse. At the same time this method of construction reduced the warehouse yard inventory of considerable old pipe and old sheet metal. Another feature of the station is it contains no wood except the office fixtures.

This plan was first tried out at Seminole where a manifold building was built with old pipe and sheet metal. When it was decided to build Maud station, similar material was used.

Maud station has six 200 horsepower motors driving the six centrifugal pumps. Two pumps are connected in series giving the station three units, each with a capacity of 18,000 barrels daily; two 10 by 18 suction pumps driven by two 15 horsepower motors gather the crude.

Three-inch pipe was used for the uprights and they are bolted to the concrete foundation. The rafters and braces were made with 2-inch pipe and all joints welded.

The walls and roof are made with old sheet metal taken from the yards and the sheets are fastened to the frame with lead nails. The fire-wall is made with metal laths and plaster, the laths being wired to the 2-inch framework and the plaster put on both sides.

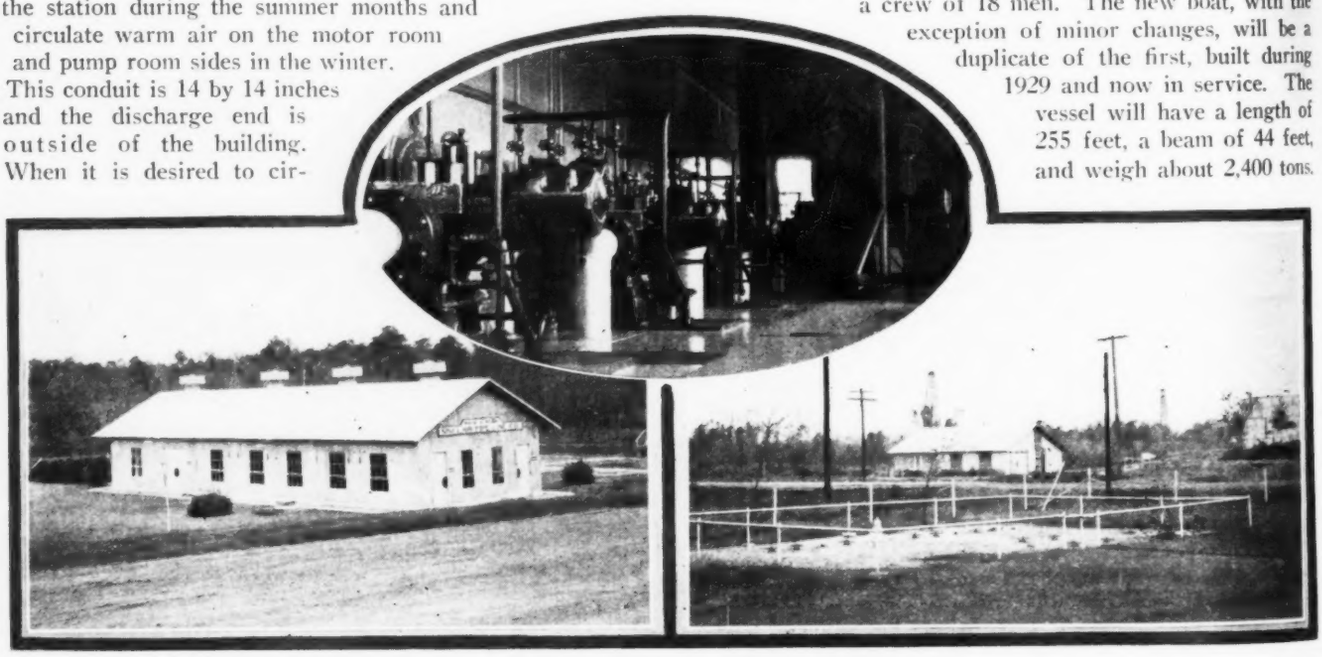
No craneways were built but a portable hoist, the frame of which was made out of old pipe, is used to lift the heavy parts on the pump room side.

One of the construction features is the concrete conduit running under each motor, used to take the hot air out of the station during the summer months and circulate warm air on the motor room and pump room sides in the winter. This conduit is 14 by 14 inches and the discharge end is outside of the building. When it is desired to circulate warm air in the building a lid is closed over the discharge end and ports inside are opened. Hoods have been placed over all of the motors to control the circulation.

All of the station wiring is in conduits and the wires leading from the sub-station pole to the building are in underground conduits, eliminating the necessity for braces on the building where the wires would enter. As an emergency protection each oil enclosed motor switch can be cut off from the outside. Chains are attached to the switch handles and extended through the building as shown in the accompanying photograph. In case of an emergency the engineer can shut down each motor from the outside.

To further eliminate the fire hazard virtually everything in the building is fireproof. The wrench and tool racks and tool box are made of steel and the instrument board made of steel plate.

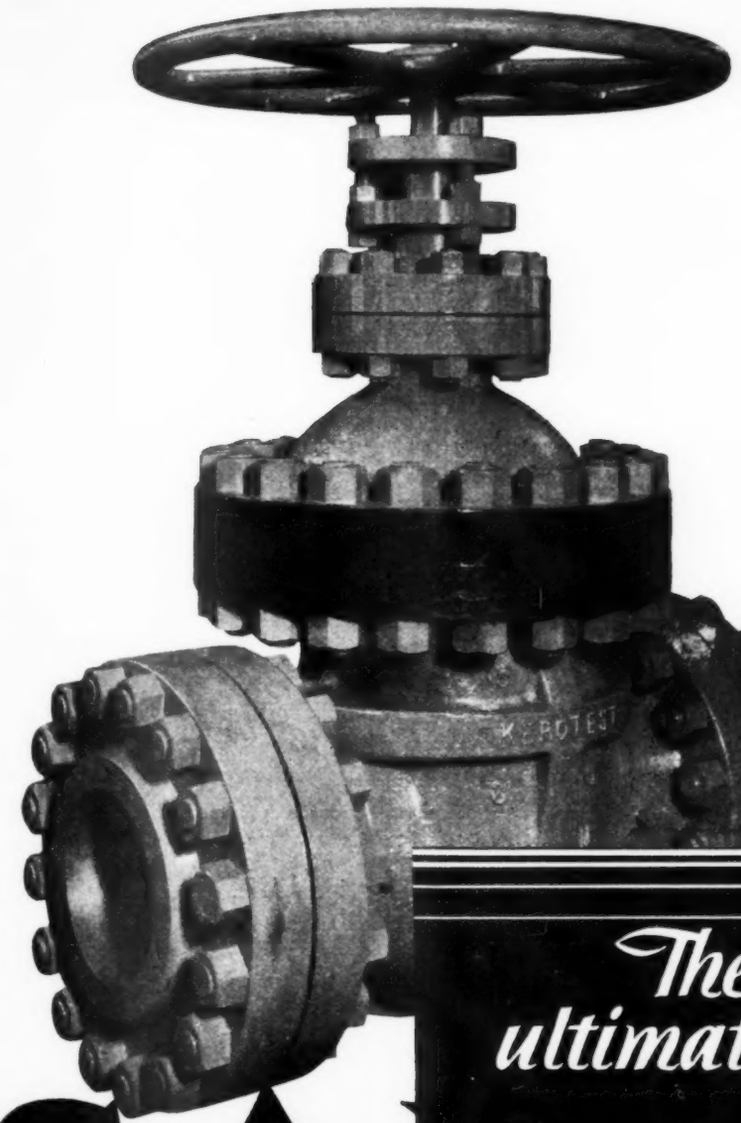
The station is made more attractive by painting and landscaping the station grounds, particularly with flowers. The floors are painted gray and the walk-ways around the pumps and motors have been covered with strips of roofing material painted black.



Left—General view of the Sinclair's Maud station. Note handles on chains attached to motor switch handles. Center—Interior of pump room side of Maud station, giving an idea of the construction features of the framework. Right—Gates on the station's manifold.

Tide Water's Second Diesel Electric Tanker

CONSTRUCTION is soon to commence of a second coastwise, Diesel-electric tanker for the Tide Water Oil Company to carry gasoline and lubricating oil. Like the first boat, her capacity will be approximately 20,000 barrels of gasoline and approximately 55,000 gallons of lubricating oil, the latter to be carried in individual tanks in the forward hold space. Her route will be along the Atlantic coast, the same as her sister tanker. She will carry a crew of 18 men. The new boat, with the exception of minor changes, will be a duplicate of the first, built during 1929 and now in service. The vessel will have a length of 255 feet, a beam of 44 feet, and weigh about 2,400 tons.



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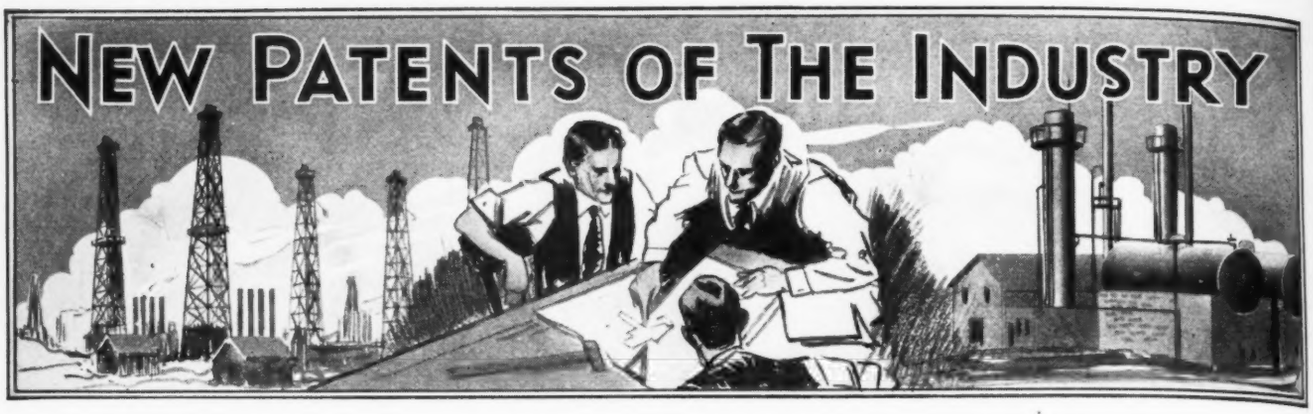
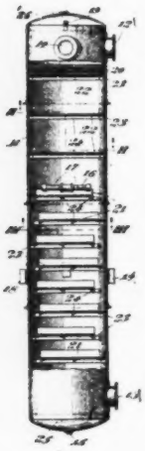
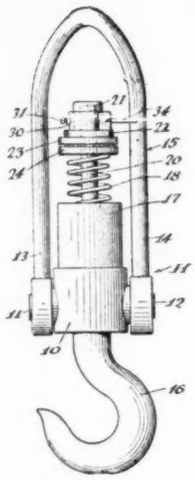




1,734,880. APPARATUS FOR REFINING CRUDE PETROLEUM. FREDERICK GARTHEWAITE RING, Winchester, Mass., and PERCY GEORGE PARIS, Bethlehem, Pa.; said Paris assignor to Bethlehem Steel Company. Filed Aug. 27, 1924. Serial No. 734,367. 4 Claims. (Cl. 196—139.)

1. In a separator for removing the more volatile constituents of a preheated crude oil prior to the charging thereof into stills, the combination of a substantially closed shell body, baffles with their lateral edges upstanding to extend the passage of said preheated oil in a tortuous continuous stream therethrough, said baffles being disposed transversely in the shell with their longitudinally terminal edges in staggered relation to one another and their lateral edges in substantially vertical alignment, a heating coil to maintain said volatile constituents at their vaporizing temperature, a scrubber for the vapors evolved, an inlet means for the crude oil, and independent outlet means for each of the separated products.

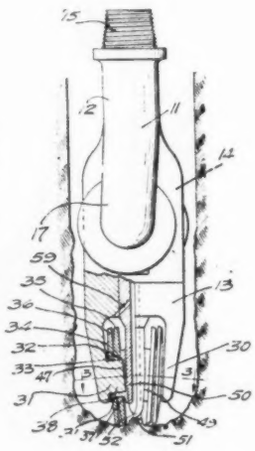


1,733,508. ANTISWIVELING DEVICE FOR SUSPENSION HOOKS. BURT STANLEY MINOR, San Pedro, Calif., assignor to Regan Forge and Engineering Company, San Pedro, Calif., a Corporation of California. Filed Oct. 24, 1927. Serial No. 228,282. 3 Claims. (Cl. 294—82.)

1. The combination with a yoke embodying parallel arms, a yoke cross bar carried by the lower end of the yoke arms, a hook having its shank rotatably and slidably directed through said bar and extending between the yoke arms, means for preventing a swiveling action of the hook comprising a latch arm pivotally mounted on the upper end of the hook shank, the outer end of said arm adapted to engage a yoke arm when the latch is swung to a latched position, and a spring pressed plunger mechanism on said yoke shank disposed below the inner end of the latch arm, the plunger engaging the latch arm to maintain the same against movement in either of its latched or unlatched positions.

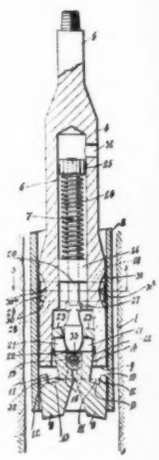
1,733,372. SPACED-LEG REAMING DISK BIT. FREDERICK W. HILD, Los Angeles, Calif. Filed Nov. 8, 1924. Serial No. 748,564. 20 Claims. (Cl. 255—71.)

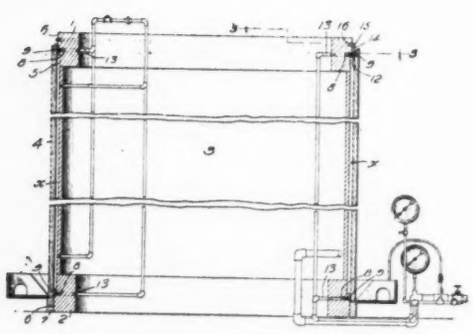
18. A disk bit comprising: a body; a bearing member supported by said body; and a securing pin adapted to be inserted from the upper end of said body and into the path of withdrawal of the bearing member for retaining said bearing member in place.



1,733,452. UNDERREAMER. JOHN W. DOODY, Los Angeles, Calif. Filed Dec. 13, 1926. Serial No. 154,465. 3 Claims. (Cl. 255—75.)

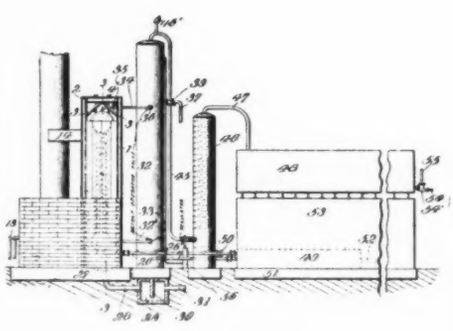
1. In an underreamer, the combination with a tubular body, a pair of reamer cutters having shanks adapted to extend into an axial chamber formed in the body, a spreader block removably mounted intermediate the shanks in the chamber, cutter head formed on the shanks below the body, the cutter heads having arcuate pockets formed in their upper ends adapted to closely fit the periphery of the body, and means for yieldingly holding the cutters in expanded position.





1,734,805. APPARATUS FOR TESTING PIPE. PRIMM R. HAWTHORNE, Sharon, Pa., assignor to The Petroleum Iron Works Company, Sharon, Pa., a Corporation of Ohio. Filed Nov. 1, 1928. Serial No. 316,551. Eight Claims. (Cl. 73—51.)

1. Apparatus for testing pipe, including an interior pressure-resisting body having an outside diameter slightly less than the inside diameter of the pipe section being tested, said body adapted to be arranged concentrically within the pipe section being tested, sealing means carried by the body and adapted to be projected into contact with the pipe section to seal the space between the body and pipe section, and means for admitting testing fluid to such space.

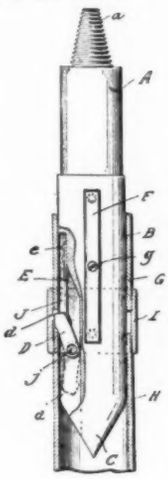


1,734,827. CRACKING STILL. GEORGE L. PRICHARD and HERBERT HENDERSON, Port Arthur, Tex., assignors to Gulf Refining Company, Pittsburgh, Pa., a Corporation of Texas. Filed March 4, 1922. Serial No. 541,126. 7 Claims. (Cl. 196—108.)

1. Apparatus for cracking oils comprising a fire box and a heating chamber in communication therewith, supports, a still comprising an upper and lower drum connected by tubes and suspended in the heating chamber by the supports, and fire brick or the like surrounding the still and suspended therewith above the level of the fire box.

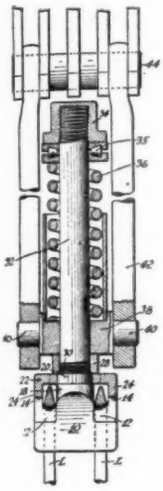
1,733,360. UPSHOT PIPE RIPPER. SAMUEL P. POWERS, Wooster, Ohio. Filed Feb. 9, 1924. Serial No. 691,855. 2 Claims. (Cl. 81—188.)

1. An upshot pipe ripper, comprising in combination, a cylindrical tool body terminating at its lower end with a conical point, and provided with a pair of longitudinal slots opposite each other in said body; a longitudinal slot in said body intermediate said pair; a ripper knife pivotally hung diagonally in said slot and adapted to project outwardly, said knife terminating with a breaking face extending laterally from its cutting edge, substantially at right angles with its axis, a resilient member operable in said intermediate slot against said knife when in operative position; a pair of friction plates reciprocally operable in said pair of slots, each plate perforated intermediate its ends, a bolt passed loosely through the perforation into said body, to guide and limit the movement of said plate, and resilient members set under each plate to impel it outwardly against the adjacent pipe casing, substantially as set forth.



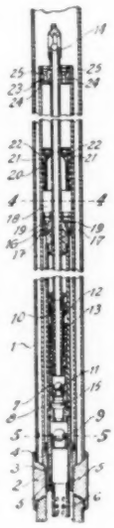
1,733,509. HOOK FOR HANDLING OIL-WELL CASINGS AND THE LIKE. BURT STANLEY MINOR, San Pedro, and JAMES J. REGAN, Los Angeles, Calif., assignors to Regan Forge and Engineering Company, San Pedro, Calif., a Corporation of California. Filed Apr. 14, 1928. Serial No. 269,967. 1 Claim. (Cl. 24—241.)

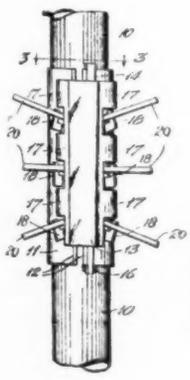
In a hook for handling oil-well casings and the like, a shank providing a vertical axis, a pair of hooks arranged back to back and supported by said shank, each shank having a thick bight of massive construction to avoid development of fatigue lines, the loops of said hooks being shallow and providing short hook ends, a relatively narrow closure plate mounted on the shank above the hooks and arranged to rotate thereon in a horizontal plane and having overhanging lips cooperating with the hook ends



1,732,617. APPARATUS FOR RAISING FLUIDS FROM OIL WELLS. LUTHER M. ROBINSON, Blackwell, Okla. Filed June 13, 1927. Serial No. 198,380. 2 Claims. (Cl. 103—189.)

1. In combination with a string of pipe having a seating collar, a working barrel carried by the seating collar, a working barrel within the first named working barrel, independent plungers for the working barrels, a rod for simultaneously operating the said plungers within the respective working barrels, each working barrel having an independent inlet, part of the first named working barrel extending above the second mentioned working barrel and standing valves at the tops of the respective working barrels.



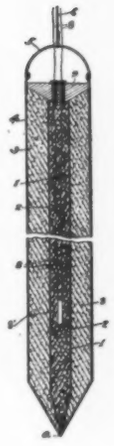


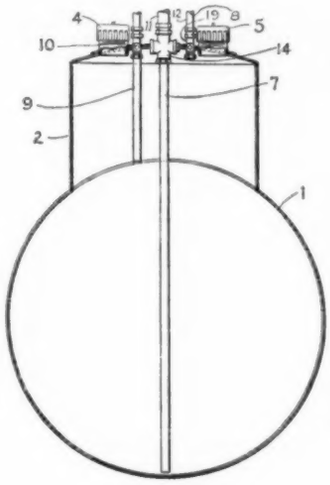
1,738,667. WELL-DERRICK CONSTRUCTION. GEORGE G. REEVES, Shreveport, La. Filed Feb. 7, 1928. Serial No. 252,484. 5 Claims. (Cl. 189—19.)

1. In a well derrick construction, a corner post coupling including a longitudinally split tubular body having its longitudinal edges flanged outwardly, girt and brace rods, interfitting lug and socket connections formed on said body and the ends of said rods, a channel clamp engaging said flanges and arranged to engage the connections and prevent disengagement thereof, and a wedge engaging between one of said body flanges and a flange of said clamp.

1,734,670. MEANS FOR CEMENTING OIL, GAS, AND WATER WELLS. HASKELL M. GREENE, Taft, Calif. Filed Sept. 5, 1923. Serial No. 661,019. 2 Claims. (Cl. 61—36.)

1. The well cementing cartridge set forth, comprising a sheet metal casing, an explosive charge in said casing; a detonator located at a lower portion of said explosive charge, and a charge of cementitious material surrounding the explosive charge at the level of the detonator and extending a considerable distance above the detonator so that when the detonator charge is ignited the force of the explosion at the lower end of the cementitious charge will operate to compact a lower portion of the cementitious material against the wall while the cementitious material above the detonator will be freed to descend by gravity to close the hole with an easily drillable core inside the cementitious material compacted by the force of the explosion.



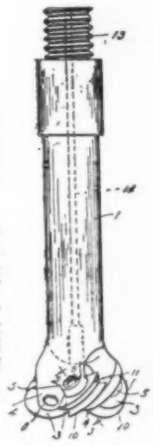


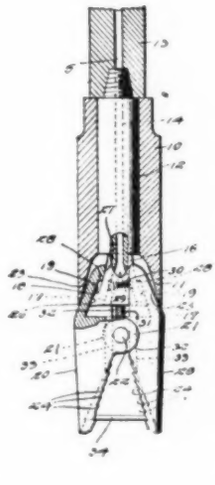
1,735,484. LOADING TANK CARS AND THE LIKE. HARRY C. WIESS, Houston, Tex., assignor to Humble Oil & Refining Company, Houston, Tex., a Corporation of Texas. Filed May 7, 1925. Serial No. 28,583. 3 Claims. (Cl. 220—86.)

1. In a liquid receptacle of the type comprising a body portion and an expansion dome connected thereto, a charging pipe and a gas vent fitted in said dome, a bottom draw-off valve in the body portion and a bottom-valve actuating rod fitted in the dome and extending to the exterior of the same, whereby it may be actuated without removing the dome.

17,522. ROTARY DISK BIT. VAN J. KUBIN, Torrance, and PERRY FUNDERBURK, Huntington Beach, Calif. Filed Sept. 17, 1927. Serial No. 220,199. Original No. 1,599,094, dated Sept. 7, 1926, Serial No. 42,042, filed July 7, 1925. 3 Claims. (Cl. 255—71.)

1. A drill bit including a stem, a plurality of arms projecting from the lower end portion of said stem, disk cutters journaled in said arms, each cutter being annularly grooved at its periphery to have a pair of spaced cutting edges, said arms being angularly related to the axis of said stem so that one cutting edge of each cutter will cut the bottom of the well bore and the other cutting edge will cut the side of the bore.





1,738,789. OUTSIDE FISHING TOOL FOR USE IN DEEP WELLS. EDGAR H. NEWKIRK, Oklahoma City, Okla. Filed Nov. 5, 1927. Serial No. 231,316. 4 Claims. (Cl. 294—115.)

1. In an outside fishing tool, a pair of jaws pivoted intermediate the ends thereof, a wedge disposed between the upper ends of the jaws, said wedge and jaws being inseparable but capable of relative movement in the general direction of the longitudinal axis of the tool, said wedge during such movement, when in a direction causing the wedge to approach the outer ends of the jaws, causing adjacent faces of the lower ends of the jaws to approach one another, adjacent faces of the lower ends of the jaws having gripping teeth, the upper ends of the jaws combining to produce a substantially conical member, a plunger upon the lower end of which the wedge is secured and at the upper end of which means are provided for engagement with a string and a barrel loosely surrounding said plunger and having at its lower end a downwardly tapering bore adapted to receive the conical member produced by the jaws.

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